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PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

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Two Links in the Lincoln Highway

Probably the most pretentious cross-continent highway proposition and the one which has come nearest to complete realization in this country is the Lincoln Highway. This aims to give a continuous route of well-paved roads extending from the Atlantic to the Pacific. However, it will be continuous as a route only and will consist of a number of links of varying physical characteristics and different degrees of perfection. It will cross mountains, plains and rivers and have a total length of about 3,300 miles, while it will vary in elevation from an altitude of 8,300 feet above sea level in Wyoming (between Cheyenne and Laramie) to nearly 100 feet below sea level in the crossing of the Hudson River.

Features of interest as well as scenic beauty are found all along the route. In the mountain wildness of the Sierras, the broad expanses of the plains and the busy thoroughfares of the cities through which it passes, will be found all kinds of conditions confronting road planners and road builders.

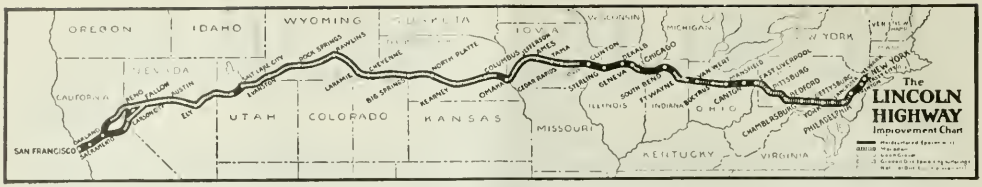
Two of the links of this highway that are at present of special interest are the "Ideal Section" in Indiana and the Hudson River tunnel between New York and New Jersey. Descriptions of these are given in this issue.

The "Ideal Section" of the Lincoln Highway

Several references to and descriptions of the "Ideal Section" have been given in PUBLIC WORKS during the past two years. The construction of the pavement proper has just been finished, but much remains before the section is fully completed. Early in the Spring the grading and surfacing of the shoulders, the landscaping of the right-of-way and the installation of the gravel pathway for pedestrians will be begun under the supervision of Jens Jensen, the landscape architect of the Lincoln Highway Association. At the same time the installation of the modern lighting system especially designed by the engineers of the General Electric Company (see PUBLIC WORKS for April 16th, 1921) will be undertaken, and it is expected that a camp site will be opened at some point along the Ideal Section and, following the completion of the section, that a memorial will be built to H. C. Ostermann, late field secretary to the Lincoln Highway Association, who was killed along the road in June, 1920.

While called the "Ideal Section," its designers

"IDEAL SECTION" OF LINCOLN HIGHWAY NEAR WEST END



ROUTE OF LINCOLN HIGHWAY FROM NEW YORK TO SAN FRANCISCO

do not claim it to be perfection, but rather as an object lesson of what is considered at the time to be the best practice in highway construction. Also, it is not assumed that every state or even any state can build all its roads after this as a pattern, since the cost would be prohibitive; but rather this is an ideal toward which they are expected to approximate as closely as conditions warrant.

This section lies between the towns of Dyer and Schererville in Lake County, Indiana, about 37 miles south of Chicago. It is 1½ miles long and has a right-of-way of 125 ft., only 100 ft. of which is being developed at present, but options on 12½ ft. additional on each side are secured to provide for utilitarian and esthetic development. The property required additional to that already publicly dedicated as a highway will be given to the State of Indiana by the Lincoln Highway Association. The road has been accepted by the Bureau of Highways as a federal aid road and aid will be granted at the rate of $20,000 per mile. The U. S. Rubber Company has contributed $120,000, the State of Indiana $49,500, and Lake County, Indiana, $25,000. The actual cost of the paving alone is given as $93,000.

The engineers of the "Ideal Section" are Lockwood, Greene & Company, and the contractor for the concrete paving was J. C. O'Connor & Sons. Jens Jensen is consulting landscape architect and W. G. Thompson consulting highway engineer for the association.

In deciding upon the details of the "Ideal Section," a technical committee was appointed by the association consisting of W. D. Uhler, A. R. Taylor, H. E. Breed, Clifford Older, T. R. Agg, F. R. White, A. N. Johnson, Edward R. Hines, Sidney D. Waldon, L. H. Wright, A. R. Hirst, A. H. Blanchard, J. M. Ritchie, W. G. Thompson and Elmer C. Jensen. This committee asked and received the advice of many other highway engineers and specialists, and received the cooperation of the General Electric Company in developing a lighting system, so that this section may be said to represent the composite opinion of the most prominent highway experts of the country.

Concrete was selected as the material, but with no intention to convey the idea that concrete is considered the ideal pavement—something that probably never will be attained. The width of the concrete pavement was decided upon as 40 ft., to provide four lanes of continuous travel. While it is recognized that, as Prof. A. M. Johnson has said, "highway plans contemplating an extended system of highway of greater width than is required for two lanes of traffic are extravagant and have no economic justification," human safety was considered to be even more important than purely economic considerations, and it was believed that this would be greatly advanced by the construction of a wider highway.

On each side of the concrete pavement there will be constructed five feet of earth shoulder, just outside of which will be a submerged drain pipe with catch basin at intervals. Concrete post for supporting the lighting units will be placed just outside of the shoulders. About 10 ft. from the edge of one shoulder will be constructed a five-foot sidewalk.

It was decided to design the pavement with a view to carrying 28,000 lbs. total gross load, a maximum gross load of 8,000 lbs. on each rear wheel, and a limit of 800 lbs. per inch of tire width. Although no theory was available for the exact calculation of a pavement to carry this

LINCOLN HIGHWAY CROSSING RIDGE BETWEEN CASCADE LAKE AND EMERALD BAY

load, a ten-inch slab was arbitrarily decided upon, on a sub-base crowned parallel to the roadway surface, of concrete mixed 1-2-3. Reinforcing metal was used at the rate of about 80 pounds per hundred square feet placed three inches below the top of the slab. The concrete pavement was built in two sections, a longitudinal joint being placed in the center of the roadway. Three-quarter-inch steel bars five feet long were placed across this longitudinal joint three feet apart to hold the two sections at a uniform surface. The cross-section is parabolic with a total crown of 2½ inches.

The drains, as stated, are buried, open drainage ditches being considered unsafe. Four-inch drain tile is buried about three feet below the surface in a trench 18 inches wide, which is filled around and above the tile with gravel with a few inches of earth at the top.

The lights will be mounted on concrete poles 35 feet high and spaced 250 feet between centers staggered on opposite sides of the roadway. Lamps will be 2,500 lumens, mazda C, 6.6 amperes. Current will be transmitted through a steel armored cable buried about 12 inches in the ground.

As stated above, the shoulders, sidewalk, lighting system, etc., have not yet been installed, but the concrete road itself has been completed and will repay an inspection. It is readily accessible from Chicago, and the association hopes that many of the engineers and highway experts attending the Good Roads Congress will inspect the work so far completed during their attendance at the convention.

Hudson River Vehicular Tunnel

A difficult foundation of great depth formed by hollow steel piles driven 250 feet to penetration in solid rock.

The vehicular tunnel under the Hudson river from Canal street, New York, to Jersey City, consists of two 29½-foot concrete-lined cast-iron tubes about 40 feet apart on centers, each having a single two-line one-way traffic roadway and a narrow footpath at an approximate depth of 93 feet below mean high water. They will have an estimated yearly capacity for 15,000,000 vehicles, and for this maximum service provision will be made to change the air forty times per hour, thus eliminating danger from the poisonous gases produced by the motor cars. A fresh air supply of 3,600,000 cubic feet per minute will be required.

To circulate such an immense volume of air through the tunnel, there will be installed a large mechanical equipment and two pairs of ventilating shafts, 3,375 feet apart, just within the pierhead lines. At the foot of each of these shafts there will be rigid connections to the tunnels on the land and river sides.

On the west side of the river the shafts and tunnels will be located in mud and silt, which is not considered reliable for sustaining very heavy loads without settlement. It was therefore decided to support each of the shafts on a foundation consist-

DRILLING PLATFORM AND OIL WELL MACHINES FOR SINKING 24-INCH FOUNDATION PILES

ing of forty-two 24-inch steel and concrete piles driven to penetration in the solid rock about 250 feet below mean high tide. The construction of one of these pile foundations ready to receive the ventilating shaft, which will weigh about 15,000,000 pounds exclusive of the portion of the tunnel weight it carries, has been successfully accomplished by a modification of methods and equipment developed for sinking oil wells.

Permanence and stability that eliminate serious danger from otherwise possible unequal settlement have thus been quickly and economically secured by simple standard methods and an important advance in foundation work has been attained which will be of special value in supplementing the possibilities of the foundations in soft materials that have hitherto been chiefly constructed by the sometimes uncertain open dredging method, or the costly pneumatic caisson method which is strictly limited to depths corresponding with the maximum safe pressures in working chambers (about 50 pounds above atmospheric).

A temporary working platform having been constructed at the site of the shaft, steel pipes, 24 inches in diameter and 20 feet long, weighing about 3,100 pounds each, were delivered there and three pieces assembled together by outside screwed sleeves to form a 60-foot section. These were successively centered, plumbed with accuracy in their required locations, and driven at the rate of about 2½ feet per hour by the combined effects of their own weight, the operation inside of a heavy drilling bit, impact from a hammer, and frequent bailing with a long cylindrical bucket.

As the pipe descended, additional lengths were screwed on top, and when it finally reached rock the latter was drilled about a foot and the pipe was driven down to the bottom of the hole to give it good bearing and lateral stability.

3,000-LB. OIL WELL BIT FOR SINKING 24-IN. STEEL PILE

After the driving had been completed, the pipe was cleaned out, assembled reinforcement placed in it and the pipe filled with concrete up to the cutoff level. The upper part of the pipe, from 100 to 110 feet long, was cut off by a tool suspended in the pipe and operated from the working platform. When the cutoff portion of the pipe, which penetrated 60 feet or more through the mud and silt, adhered too firmly to the latter to be pulled by the derricks available, it was easily loosened and quickly brought to the surface by means of air forced into it at a pressure of about 100 pounds per square inch.

The footings for each of the two shafts on the west side of the river will be built in steel pneumatic caissons floated to position and sunk through the pipe driving platform until their cutting edges reach an elevation slightly below the cutoffs of the foundation piles, which will eventually be imbedded in the concrete deposited in the working chambers of the caissons and forming the bottoms of the ventilating shafts.

The work is being done under the direction of the New York and New Jersey State Bridge and Tunnel Commissions, Clifford M. Holland, chief engineer. Booth & Flinn are the general contractors and Sprague & Henwood are contractors for the pile foundations.

Michigan Highway Work

It is announced by Frank F. Rogers, state highway commissioner of Michigan, that the Highway Department has planned an expenditure of $16,253,194 for 1923, which will be used in the improvement of 978 miles of road, of which 490 miles will be federal aid road and the remainder will be paid for from the state highway bond issue. Three hundred and thirty-four miles of roads will be paved. This large amount of work is made necessary by the curtailment of the 1922 program by inconveniences caused by the railroad strike and consequent shortage of materials.

Of the cost of this year's work, $10,000,000 (the fifth and final instalment under the present law) will be obtained from the sale of state bonds, while the counties will provide $3,273,791. The coming legislature will be asked to appropriate $4,000,000 for interest on and a sinking fund for retiring the bonds, and also appropriate $2,000,000 for road maintenance and $2,500,000 for state aid on non-trunk line roads.

Refuse Incinerator Bids

On December 18th the City of Allentown received bids for a refuse incinerator having a capacity of 70 tons in 24 hours, to be constructed on foundations and in a building, both of which, together with the chimney, are to be furnished by the city. Four bids were received complying with the specifications, which called for a steam boiler and provision for creating power to be used in pumping sewage, the bidders being the Balmer Corporation, $49,500; Bartlett & Snow, $57,760; Hiller Engineering Company, $62,900, and the Universal Destructor Company, $70,000.

New and Improved Contractors' Appliances

The following information concerning contractors' appliances has been furnished to us by the manufacturers in response to a general inquiry made for a description of machinery, tools, etc., that were introduced by them during the year 1922, or important improvements made in machinery already on the market. Readers will therefore understand that no attempt is made in this article to list all the available machinery—which in fact would have been impossible within the limits of this magazine. We have however done our best to obtain information concerning all new appliances designed for use by contractors, especially those engaged in highway work.

Earth Handling Machinery

AUSTIN-WESTERN ROAD MACHINERY COMPANY

This company gives as its 1922 contribution to road machinery the Austin "Pup," Pressure Road Plane, and Double-Ender.

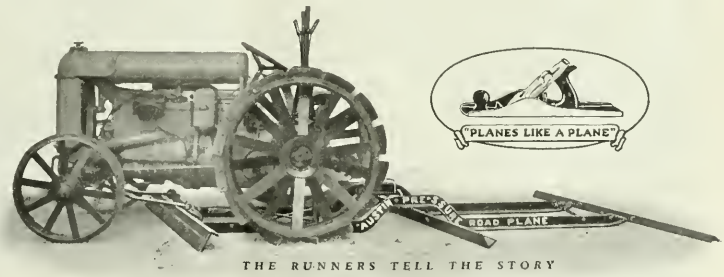
The Austin Pup was described in our December issue. It consists of a small, three-wheel road roller weighing only three tons. It was developed for preparing subgrade, but can also be used for rolling gravel, stone or earth roads, or drives in parks or cemeteries, or for pulling a wheel or drag scraper. It is built with the Fordson tractor as the propeling basis. The total length is 12 ft. 6 in., width, 5 ft., weight on rear rolls, 4,120 lbs., and on front rolls, 1,880 lbs.

The Austin Double-Ender consists of extensions provided for every size of the regular line of Austin graders, to be attached to each end of the blade, permitting three feet to be added to one or both ends at any time and removed when not needed. The peculiar feature of the Austin extension is that when not needed it is not removed but is merely swung back behind the blade and does not interfere with any operation of the machine. In addition to this, the extensions can be set at an angle with the blade and make of the blade a wheel scraper holding from one to two yards of earth for filling in hollows. They are furnished as extra equipmem with new graders or can be attached easily to old ones by drilling a few holes in the blade.

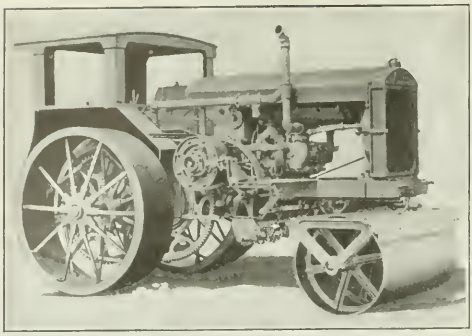
The Austin Pressure Road Plane is made to be attached to a Fordson tractor and is believed to differ in two important respects from other road planes or levelers. One is that the cutting edge is carried on the front of a pair of long runners, corresponding to the base of a carpenter's plane, which runners prevent the planing blade from cutting into any but the high spots A fixed blade following behind fills the low spots with the material cut off, while a third loose blade levels off the road. Another feature that is believed to be unique is that part of the weight of the tractor is transferred to the runners of the plane, the operator being able to increase or decrease the amount of pressure at will. It is also possible to work one end of the cutting blade lower than the other. The whole outfit is very compact and turns in a short radius. The pressure plane consists primarily of a pair of ten-foot runners attached beneath the tractor and extending several feet behind it, to which are fastened in front the planing blade, behind this the packing blade, and in the rear the leveler. Two levers with special pressure rods are used to raise or lower either side independently of the other and transfer the weight of the tractor to the plane. While traveling from place to place the entire attachment is raised off the ground. It is claimed that, with the aid of the weight of the tractor this plane will take off the high spots in the hardest and dryest of roads. On the other hand, by removing the pressure it can be used on soft or sandy roads. The use of the Fordson tractor carries with it the advantage of ability to secure repair parts, which are carried by all Fordson dealers. The planing blade is seven feet six inches long, as are also the packing blade and leveler. The entire plane weighs 550 pounds.

NEW AVERY ROAD ROLLER

The improved Avery 25-50 road roller has a roller of extra heavy diameter so as to roll readily over high piles of loose dirt that are thrown up by the grader. The front roller is also more than sufficiently wide to overlap the rear wheels and is mounted on a large turntable revolving on one-inch steel balls. The rear wheels are furnished either with the regular steel rim, or extra heavy with cast rims. When equipped in



AUSTIN PRESSURE ROAD PLANE



AVERY GAS OIL ROLLER

the latter way, this makes an ideal 10-ton roller.

The roller has the same motor and exclusive features as are found in the regular Avery tractors of similar size. The 1923 model has a new improved cooling and oiling equipment, including cellular radiator, water pump and fan and several other refinements. The chief advantage claimed for this equipment is that, when building a dirt or gravel road, by rolling and packing it from the subsoil to the top surface at the same time the grading is done, there results a smooth surface which is immediately available for traffic, does not soften easily with rain nor rut with the wheels of passing vehicles.

BEACH MANUFACTURING COMPANY

A dragline bucket for removing marl from marl beds was put out last year by the Beach Manufacturing Company, which company also perfected an arrangement whereby three wheel scrapers of special design can be hitched behind a Cletrac or a Fordson. One man can load the three wheel scrapers in succession more easily than he can a horse-drawn scraper. The wheelers are adjusted to track each other so that the three and the tractor can turn in a circle of 16 to 21 feet.

The company has also built a new gravel screen plant which it says works on an entirely new principle, and which is small enough to be shipped in one end of a common box car, but has a capacity of about 300 cubic yards a day.

GOOD ROADS MACHINERY CO.

This company last year brought out three new machines—the "Winner Highway Patrol" road grader, "Champion" pressure oil distributor, and "No. 16 Champion" steel rock crusher.

Road Grader. The Winner Highway Patrol is described by the maker as "a simple, sturdy, convenient and serviceable patrol machine." It is operated by one man and two horses. Almost entirely of steel with all parts interchangeable. Wheels concave; front, 22 in. diameter, rear, 30 in. Hubs of all wheels fitted with dust-proof grease cups. Blade, 6 ft. long, can be reversed or adjusted to any angle, or shifted laterally two feet outside the line of the wheels, and its tilt adapted to any soil, having a range of 25 degrees.

LEE TRUCK BODIES

The Lee Trailer and Body Company about a year ago brought out its Lee 4-D and B Bodies. The 4-D can be used with a Ford truck. When so used, the loading edge is 4 ft. 4 in. from the ground, believed to be the lowest dump truck body on the market. The standard size is one cubic yard level full, but for materials lighter than sand, asphalt, etc., the capacity can be increased by adding side boards. By pulling one handle the body rolls over and dumps automatically, the end gate opening automatically, and the body returning automatically when empty. The dumping angle is 45 degrees. Despite the lowness of the body, there is 14 inches ground clearance when dumping. Special bodies are made for light material, such as street sweepings; also a steel watertight body for garbage.

LINK BELT CRAWLER TYPE CRANE

The Link-Belt Company will exhibit at the Road Show, in its space in the balcony at the right of the main entrance, in addition to its portable loader and belt conveyor, a new crawler-type crane which was first put on the market in 1922.

This crane can operate with hookblock, grab bucket, dragline bucket, skimmer bucket, steam shovel attachment, electric lifting magnet, wood grapple or pile driver attachment. It can lift 10 tons at 12 feet radius or 3 tons at 30 feet radius. The boom is 35 feet long. It can make four complete revolutions per minute, travel three-quarters of a mile per hour and easily climb a twenty per cent. grade. One man can operate the entire machine.

The first of these cranes to be put in operation was used in low, swampy ground, removing the muck over-burden, digging sand and building subgrade for a road between Gary and Michigan City. In spite of overloading and unskilled handling, it excavated and placed on the road in about 2½ months, over 30,000 cubic yards of material. On conclusion of this work it was placed on a flat car in twenty-five minutes, moving by its own power up a temporary incline, part of which had a thirty-five per cent. grade. It then was used at a sand pit, where it loaded forty-yard gondola cars in less

LINK-BELT CRAWLER TYPE CRANE IN ACTION

than twenty minutes, using a ¾-yard grab bucket. Owing to the self-cleaning construction of the tread, the machine has never been stalled in either sand or muck.

ORTON & STEINBRENNER CRANES

Several improvements were made last year in the crawling tread cranes of Orton & Steinbrenner Co. In addition to the auxiliary steam shovel dipper the company has developed a reeved type of dipper shovel especially applicable to its gasoline and electrically driven machines. Also a skimmer scoop attachment has been added, which can be suspended from the regular crane boom without detaching it and which is used for tearing up old pavement. A new steering gear is being used with these machines which permits the crane to be turned at any time while traveling, loaded, irrespective of the relative positions of the boom and car body. Also improvements have been made strengthening the grab bucket and to other features of the apparatus.

P. & H. HOISTS AND EXCAVATORS

The following summary is sent us by Pawling & Harnischfeger Co. of improvements and additions made in their products during 1922:

"1—We brought out a complete line of electrical, gas and belt driven contractors' hoists and elevator hoists.

"2—The No. 206 '8 in 1' machine, which may be converted into shovel, skimmer, dragline, clamshell, pile driver, backfiller, or crane, had numerous improvements made. Among these are the worm-driven self-locking boom hoist, twin disk engine clutch, and improved cast steel corduroy frame, and an improvement was also made in the shovel, so that it may be converted from the standard machine into a shovel by means of adding one shaft. The crowding motion is provided with larger brake surface on the drums. The skimmer scoop was also improved so that the bucket runs out beyond the edge of the skimmer boom, making it ideal for basement work. A steel cab arrangement was also perfected which can be supplied, and the pile driver was also improved. The sheaves were all made of larger diameter so as to lengthen the life of the cables. The fair-lead was also improved to give maximum cable life.

"3—There was also brought out for general sale the No. 208 machine. This type of machine has been used for some time by the U. S. Reclamation Service for dragline work, but is now being built as a 1 yd. shovel, skimmer scoop, clamshell, pile driver, crane, etc., the same as the 206 machine. Other improvements were made on different machines."

STOCKLAND ROAD MACHINERY CO.

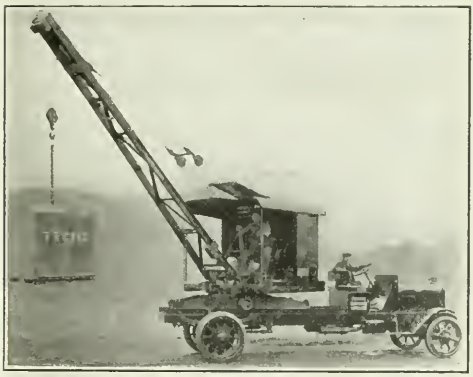
The Stockland "Master Quicklift" was put on the market in 1922 as a combined maintenance grader and light construction grader. For the former work it can be drawn by four horses, for construction grading by six horses, or a 15 h.p. tractor. With a single pull on a lever the blade is raised instantly when necessary, as for manhole covers, crossings, etc., and then returns to its exact former adjustment.

The blade is regularly 7¼ ft., or may be 6, 8 or 10 ft. if desired. The wheelbase is unusually long—10 ft. 11 in. The blade lifts 9 in. above the ground and has a lateral shift of 20 in. and pitch adjustment of 3 in. The tires are 4x5/16 in. and the tread 45 in. front wheels and 77 in. rear.

Other additions during the year were a back-sloper attachment for large blade graders, and a 3-horse dump wagon hitch; also improved wheel and Fresno scrapers and bottom-dump wagons.

UNIVERSAL CRANES

The cranes now furnished by the Universal Crane Co. were first brought out about three years ago, but were first used for road work in 1922. In that year an improvement was made on the boom operating mechanism so that the lowering is controlled mechanically to positively prevent the boom from dropping without resorting to the slow worm gear drives. It is mounted on a motor truck and can travel from job to job at motor truck speed, or on a trailer or continuous tread if preferred. It swings in a full circle; has 4 to 5 tons capacity. Gasoline engine. The crane unit, without mounting, weighs approximately 12,500 pounds.

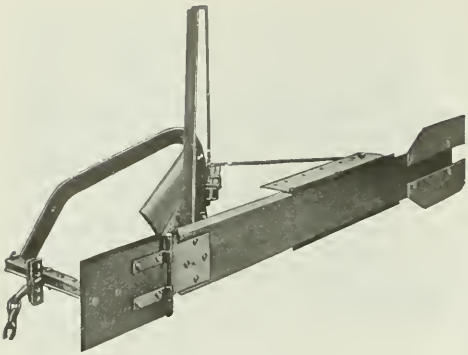


UNIVERSAL CRANE MOUNTED ON GARY 5-TON CHASSIS

Road Builders' Truck, 1923 model. This was designed by the Western Wheeled Scraper Co. to provide the increased capacity batch box that road builders are now using. The end construction is reinforced, center sills used, size of axles, bearings and springs increased. The journal box is supplied with a manganese split bushing and all loads are carried on the the center line of bearing.

Scarifier. A new type of scarifier can be attached to the company's Standard Little Western and Aurora graders, the scarifier rotating and being raised and lowered with the blade and always remaining parallel with it. By having the scarifier project about two inches below the blade it loosens the gravel or stone and cuts down bumps so that the blade may level them easily. When not in use the scarifier can be raised.

Westford Grader. A combination of the Little Western grader and the Fordson tractor, operating as a single unit. For reversing direction, the tractor can be turned independently.



BACKSLOPER AND DITCHER WITH GUIDE RUNNER ON LANDSIDE

Western Back-sloper and Ditcher. For smoothing off banks, ditches and highway cuts. Can be operated on a one-to-one slope, and for any height by using it after each successive four-foot cut. Can also be used for cutting or cleaning lateral ditches. Both edges of the blade are fitted with detachable shares, easily removed for sharpening. Steel fins that polish quickly carry all side draft.

See also Lakewood subgrader

Tractors and Locomotives

BROOKVILLE GASOLINE LOCOMOTIVES

Providing locomotive attachments to the Ford one-ton truck and the Fordson tractor, the Brookville Truck and Tractor Co. enables contractors who have these to adapt them to use for haulage on construction track, and to obtain all the advantages of Ford power, including ready replacing of parts in any part of the country. The Ford or Fordson is used intact, except for the removing of such unnecessary parts as wheels and steering apparatus, and can be returned to its original condition as truck or tractor with a few hours' work.

The company has been building the locomotive parts for the one-ton Ford for four years, but having received many requests for heavier haulage, it placed on the market in the summer of 1922 the Fordson attachments. More speed than the Fordson tractor gave was believed to be necessary, particularly in reverse, where the Fordson is limited to about 2 miles per hour. The Fordson locomotive has a speed of 6 miles both forward and reverse, and a low of 3 miles forward. The high speed in reverse eliminates the need for a turntable or Y at either terminal of the track, as the locomotive can run in reverse in the direction furnishing least resistance.

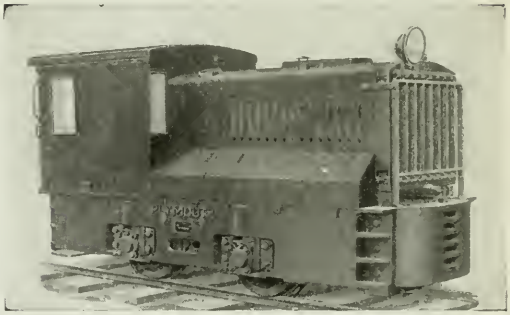
The Fordson unit is a three-ton, four-wheel drive locomotive, especially suitable for highway construction work. If, in a later job, track haulage is not desirable, it can again be changed to a tractor in a few hours. The manufacturer furnishes either the attachments alone, or the locomotive complete, and for all gauges from 24-in. to 4 ft. 8½ in.

The four drive wheels are each 20 inches in diameter, with steel face. Wheel base, 36½ inches (adapted to sharp curves). Frame, heavy ship channel. Journal boxes, railroad type. Brake shoes on all four wheels, controlled from driver's seat. Weight, 6,000 lbs., or as much more as is desired and paid for.

FATE-ROOT-HEATH LOCOMOTIVE

A 7-ton, 4-speed, gear drive gasoline locomotive has just been put on the market by the Fate-Root-Heath Co., which the manufacturers claims has developed by test a drawbar pull of 5,250 pounds on a sanded rail. It has four speeds, 2½, 4, 8 and 12 miles per hour, forward or reverse.

This excellent result is said to be due to the design and construction of the transmission. The gears are unusually large, an exclusive feature being an additional shaft and final driving gear 14½-inch diameter by 4-inch face, no jackshaft being required. The gears that are driven are the only ones in mesh. All gears are of alloy hardened steel. All bearings are inside gear case. The final drive is by means of two short, heavy chains, one to each axle, driven direct from the transmission.



PLYMOUTH 7-TON, 4-SPEED, GEAR DRIVE GASOLINE LOCOMOTIVE

The power is a Buda heavy-duty, 4-cylinder engine, with Bosch high tension magneto and Bosch starter and lighting. The clutch is dry plate type with nine driving discs. Lever brake rigging produces equal brake pressure on all four wheels. The frame is of massive construction and close to the track.

Bitumen Heaters

LITTLEFORD HEATER

A small tar and asphalt heater, especially adaptable to patrol work in road maintenance, was placed on the market in 1922 by Littleford Brothers. The heater can be handled by one man. The capacity of the kettle is 25 gallons. A convenient drain is provided at the rear where the valve is kept warm, because of its close proximity to the fire box.

The large fire box is fitted with renewable cast iron grates and the furnace shell is protected by liners of fire box steel. The rectangular kettle is removable. The seams are heavily welded, thus

eliminating all possibility of leaks and possible danger of fire. A removable cover is provided. The heater is mounted on two all steel wheels 18 inches in diameter with 2-inch by ¾-inch flat tires. The axle is 1½ inches in diameter. A handle, well braced and fitted with stiff-leg, is attached to front end at a convenient height for drawing the heater about. This heater is known as the Midget No. 69.

THE MACLEOD COMPANY

This company gives as its new products a combination gravel dryer and tar heater; a tool heater that will heat 12 tools at one time, and a 30-gallon tar kettle, all made to use fuel oil only. Also oil burners for heating kettles, an oil tank outfit for several mastic kettles or a large tar or asphalt heater.

CHAMPION OIL DISTRIBUTOR

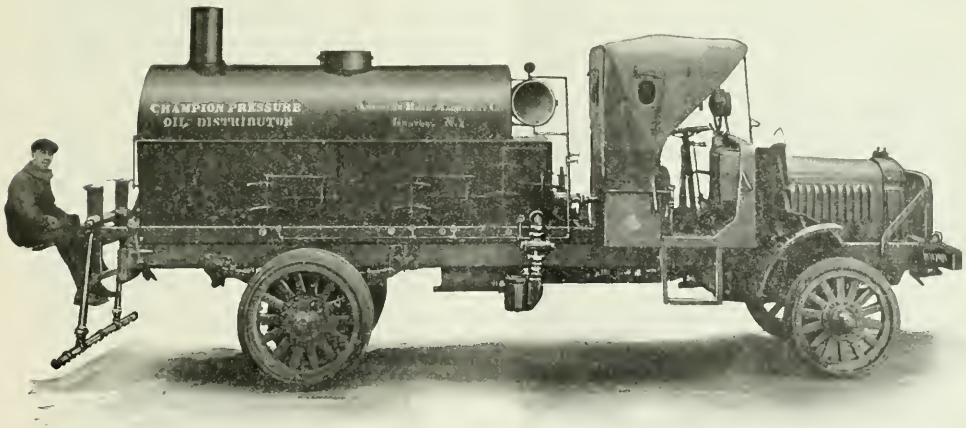
Oil Distributor. The Champion Pressure Heating Distributor consists of an encased tank, a battery of burners, a series of pipes, a distributing manifold, and a pump which is driven by a power take-off shaft of the motor transmission and is located directly in the discharge line from the tank. The unit has been used as a horse-drawn appliance for many years, but is now made as a complete detachable unit that may be removed from the chassis at will, permitting the latter to be used for other purposes. The mounting of the unit on the chassis is a shop operation, and the chassis should be sent to the company's factory, equipped with power take-off and clutch where these are available. This distributor will handle all kinds of road oils. It is claimed that the speed of trucks and size of distributing nozzles can be varied to regulate the rate of oil distribution from ½ to 2 or more gallons per square yard of roadway. The tanks are made of 600 gal., 800 gal. and 1,000 gal. capacity, for which 3½ ton, 5 ton and 7½ ton trucks, respectively, are best adapted. This is manufactured by the Good Roads Machinery Co.

THE LITTLEFORD HEATER

Concrete Machinery

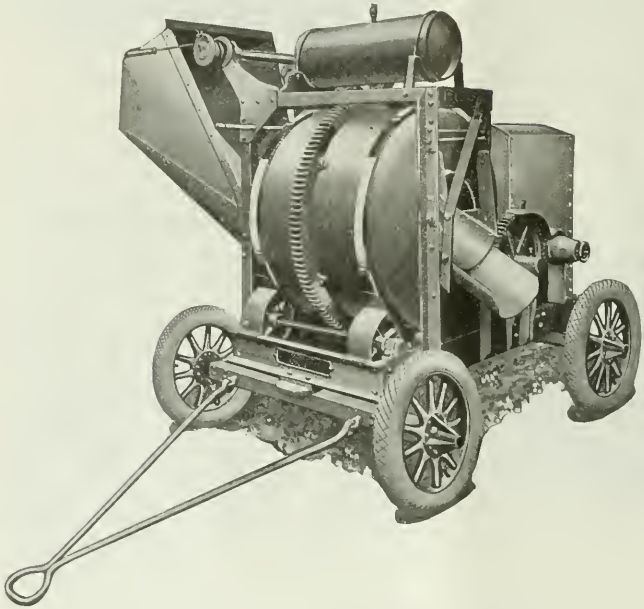
AMERICAN CEMENT MACHINE CO.

Although concrete mixers were originally drawn attached to horse-drawn rigs, nearly all are now moved about the job or from job to job hitched behind a truck and, on account of their small steel wheels, not only do these and the axles give out when drawn at a fifteen to twenty-mile speed, but the hard jolting and rattling soon works the bolts loose, the parts go out of alignment, battery and engine parts are injured and breakdowns and delays result. It has been found by the American Cement Machine Co. that by using not less than 30-inch wheels with pneumatic tires, all the noise and rattling is eliminated and the harm that it is claimed



GOOD ROADS CO. "CHAMPION" PRESSURE OIL DISTRIBUTOR

the small steel wheels do to pavements is prevented, and such rubber-tired equipment is now being furnished by that company. "Boss" one-bag highway mixers are being furnished with 4-wheeled trucks equipped all around with cord tires, while the handy size Packard tilting mixers are placed on 2-wheel Ford trailer trucks. The extra cost is believed to be more than compensated by the saving in lost time due to delays formerly experienced. While the mixers are in operation, blocks can be used under the axles, thus taking all strain off the tires. As Ford standard tires are used, they can be replaced readily and at low cost.



RUBBER TIRES ON A CONCRETE MIXER

BLAW-KNOX COMPANY

In addition to its new Batcherplant and Turntable, which were widely sold last season, this company is introducing an entirely new cement handling and loading device which has just been placed upon the market and which, the company says, "will eliminate all laborers handling cement at the paver and will also embrace a device for loading the cement quickly into the trucks with an absolute minimum of labor. This will also permit the successful use of bulk cement if desired."

The 1923 road form, type C. K., will have a one-piece stake strap and a stiffening plate of 3/16-in. steel plate. The Dreadnaught type of form is planned for use where the heaviest form is needed to withstand unusual conditions. It is made of 3/16-in. blue annealed O. H. steel plate, flanged top and bottom and reinforced with three specially designed heavy stiffening plates and stake straps.

BOAZ CONCRETE MIXERS

A concrete mixer along the same lines as the machine formerly built by the New Way Mfg. Co. is now being turned out by the Boaz Mfg. Co., which, however, has made some radical improvements in the drive system whereby it claims to reduce to a minimum the wear from sand, gravel and cement and the consequent cost of upkeep. The loading hopper is lowered from 5 to 7 inches.

The company aims to conform its entire line of mixers to the demand of the average contractor for low initial cost and low upkeep; also light weight to avoid slow, expensive moving, but with sturdy construction throughout. Above all, to provide speedy and thorough mixing and discharge.

The company has also completed the designing of a small mixer to mix 3 cu. ft. of wet material. It is of the horizontal drum type, the same as its larger machines, and is gear driven. It weighs about 1,200 lbs. and can be very easily handled by a few men. It can be rolled on a small truck and together with a few men and wheelbarrows can be quickly and cheaply moved to distant jobs. It is a low-priced and easily handled machine, but is claimed to be sturdy in construction and to mix real concrete with remarkable speed.

GALION BATCH MEASURING HOPPER

This hopper, for quickly and accurately measuring any exact quantity of crushed stone, sand or gravel from bin to truck or wagon, was described in our December issue. It can be installed on any unloader or screening plant. It is manufactured by the Galion Iron Works & Manufacturing Co.

GEORGE HAISS MFG. CO.

The additions made in 1922 by this company consist of a "path digging" bucket loader elevator to be mounted on a motor truck chassis, and wagon loaders and portable belt conveyors mounted on Fordson tractors. They have also made improvements on their "creeper loader" and "path digging" loader, increasing them in weight and strength of almost all parts, and adding a hand wheel and worm raising device for the elevator element and a tight cast iron gear case enclosing clutches and driving transmission for the creeper loader.

CHAMPION ROCK CRUSHER

Rock Crusher. The Champion No. 16 has been added this year to the other "Champions." It has 16x36 jaw opening, and with jaws set to close to 2

inches will crush 50 to 60 tons per hour, using 40 to 50 horsepower. The machine weighs 36,000 pounds. The first "Champion" crusher was manufactured thiryt-one years ago. The Good Roads Machinery Company is the manufacturer.

LAKEWOOD ENGINEERING COMPANY

This company will make several improvements in its 1923 machines. The road finishing machine will have a strikeoff adjustable so that it will operate as much as four inches below the side of the top forms, enabling the contractor to strike off the concrete for placing reinforcement or for two-course concrete. The universal joints on the drive shaft and other parts have been strengthened and several minor changes made.

A new Lakewood unit is a steel frame subgrader, which is equipped with scarifying teeth to assist in breaking up the subgrade ahead of the machine. Another new item is the grade-rooter, or light scarifier, the purpose of which is to lightly scarify the subgrade prior to the use of the mechanical subgrader.

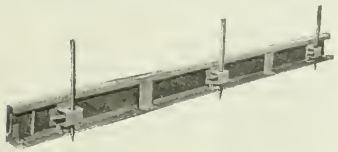
A new type of road form, known as the "Carr Form," is made with a rounded top which prevents any stones or concrete from possibly getting under the wheels of subgrader or finisher. The form has a 5-inch base, not complicated by any stake pockets, the stakes being driven anywhere so as to grip the outside edge of the base of the form. A simple wedge arrangement locks the sections of forms together, securing an even, unbroken line for the top of the forms. The sections are made 12 feet long of 3/16-inch metal, the increased length meaning fewer joints and fewer pieces to be handled.

An improvement in Lakewood track has been made by designing the curves and switches to a 60-foot radius. The batch box cars are equipped with either cage-roller or Hyatt bearings. The cement compartments of the batch boxes are now equipped with a chain diagonally across the bottom of the compartment, which aids materially in the discharge of the cement when the box is dumped, the chain falling through the cement and breaking down any arching effect that might tend to hold it in the box. The boxes are of steel with capacities of 24, 29 and 37 cubic feet, with an adjustable trunion which can be varied so as to insure easy tipping of the box for any size batch.

The 21-E Paver is a new item in this company's equipment. It is furnished with a 4-cylinder Wisconsin motor on full multiple plane traction and is built especially heavy to stand hard service. All bushings are of bronze and replaceable.

MARSH-CAPRON COMPANY

This company, besides having greatly improved its three-quarter yard M. C. Rail Track Mixer,



HOTCHKISS ROAD FORM

especially for use in central mixing plants, introduced in 1922 an entirely new machine called the Universal Junior, a half-bag machine used by road builders on culvert and curb work. It has a full-size charging platform 3x4 ft. and only 19 in. off the ground; a friction clutch, and is operated by a 3 h. p. Novo engine. It has capacity of 4 cu. ft. of mixed concrete. The drum, 36-in. diameter, makes 16½ r. p. m.

The M.-C. Hotchkiss road forms, which have been on the market for several years, will in 1923 have a 5-inch base instead of 4-inch, to provide greater bearing surface; heavier joint lock rivets and stay pockets, and a novelty at the ends of the form called "saddle plates," which are said to absolutely prevent sagging of the joint.

ROUGHIN PAVING GAUGE

An adjustable paving gauge propelled by one man is furnished by the Roughin Adjustable Paving Gauge Company. This gauge is made with adjustable crown and can be lowered any desired distance below the curb or track on which the end runners travel. For template, instead of the customary flat steel, the manufacturers have substituted a shoe that is almost half round and securely fastened and shaped to the parabola of the desired crown, which tends to compress the subgrade, cushion, concrete, etc. The weight of the gauge and operator, about a thousand pounds, is utilized in this compression. One man, standing on the gauge at the center and operating two crank handles, moves the gauge forward or backward, under high or low gear. By means of a lever the operator can raise the entire gauge from ¼-inch to 1-inch above the established grade.

CAREY TONGUE AND GROOVE EXPANSION JOINT.

A new form of "Elastite" joint manufactured by the Philip Carey Co. was described in the December issue.

General

DOMESTIC AIR COMPRESSOR

The "Domestic" Air Compressor, first placed on the market in 1922 by the Domestic Engine and Pump Company, is claimed to differ in several ways from any previous compressor. One important characteristic is that two cylinders of the gasoline engine are used for each cylinder of the compressor and the power impulse of the engine piston is directly transferred to the compressor piston. While the engine is horizontal, the compressor is vertical, thus permitting the use of the first half of the power stroke of the engine directly for compression, while the last half of the stroke with its low pressure per square inch supplies sufficient momentum to the flywheels to scavenger the engine cylinder of burnt gas.

Another point emphasized is that, while new and fresh oil is supplied only to the engine and compressor cylinders, a partial vacuum is created in the crankcase of engine and compressor, drawing this oil backward from the cylinders

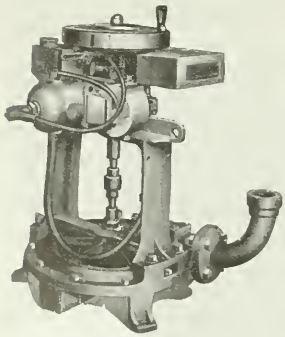
and preventing the danger of explosions in the air receiver tank by excess oil poured into it.

The No. 50 machine has two engine cylinders and one air cylinder; speed, 610 r.p.m.; displacement, 50 cubic feet per minute. No. 100 has four engine cylinders and two air cylinders, and is practically two number fifties combined. They are mounted on a 2-horse truck with 24-inch steel wheels, and have a steel cab enclosing engine and compressor. No. 50 has a net weight of 2,500 lbs., and No. 100 a weight of 4,500 lbs.

The company also manufactures a Domestic Double-Acting Force Trench Pump combining large capacity and minimum bulk and weight, which will handle water found in sewers or trenches. Being double-acting, it has maximum capacity for its bulk. Being a force pump, it will discharge to higher levels or through long horizontal pipe or hose. It can be equipped with a winch head which is capable of giving a single line pull of 300 to 500 lbs., which can be used for lowering or lifting materials in trenches or manholes, drawing cables through conduits, etc. This pump is made with capacities of 5,000 to 6,000 gallons per hour against 40 to 80 feet vertical elevation. The suction and discharge pipes are both three inches. Instead of rubber or leather diaphragm, this pump has a plain cylindrical plunger packed with ordinary water plunger packing. In addition to the gasoline operated pump, the company furnishes an electric driven pump of the same capacities.

EVINRUDE HIGH-PRESSURE PUMP

This pump was considered to be in a stage of experiment until last August, but since then a number have been put into service with results that exceeded anticipation. This pump has a length of 31 inches, width of 11½ inches and height of 7½ inches and weighs only 99½ pounds, but can deliver 1,500 gallons of water per hour through 1⅓ miles of 1½-inch pipe or against a head of 277 ft. It thus can supply water for boilers and for concrete mixing on road work extending for 2⅔ miles, from a water supply in the middle of the section.



EVINRUDE 2 H.P. CENTRIFUGAL PUMP COMPLETE

The pump is of gear type, connected to the power plant by an Oldham coupling. The engine is the well-known Evinrude 4-5 h.p. 2-cylinder. The gasoline tank has a capacity of 1⅓ gallons. The motor runs 2¼ hours on one gallon of gasoline. The suction and discharge are each 1½ inch with standard pipe thread. All parts are standard and are carried in stock at all times by factory and distributors.

In addition to the high-pressure pump, the Evinrude Motor Company makes a centrifugal pump which has been improved lately and is claimed to make an excellent contractor's pump, remarkable for its portability, high capacity and low cost. The pump weighs 115 pounds and can be moved readily by one or two men. It is used for pumping out wet trenches or other excavations, for lifting water into tanks for sprinkling carts or other uses. It can be lowered into and supported in an excavation by a sling and rope, or can be carried by two men by means of a pair of handles. The pumps are made in two sizes, one capable of lifting 6,150 gallons per hour against a 10-foot head and the other 8,400 gallons.

EASY PIPE PUSHER

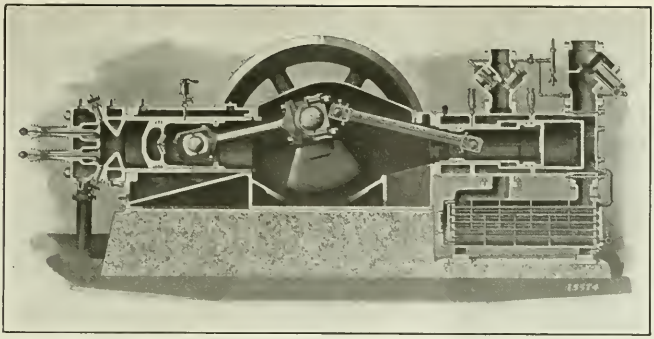
During the past year the Easy Mfg. Co. has perfected a pilot for use in pushing pipe through ground. Water under city pressure can be forced through this pilot, which washes some soils, softens others and lubricates so that the pipe can be pushed easily and accurately through soils that were before impossible. This pilot has worked successfully in sand and gravel soils and even where stones opposed its progress. Pipe from ¾ inch to 12 inches diameter has been pushed for 100 feet or more with this jack and pilot.

DIRECT-INJECTION OIL ENGINES

The Ingersoll-Rand Company has recently put on the market a horizontal direct-injection oil engine which is used for a number of purposes, among these being the operation of air compressors and ammonia compressors. The engine employs the Price system of fuel injection which eliminates the need for a three-stage or four-stage 1,000-lb. pressure injection air compressor with intercoolers.

The air injection Diesel engine has long been regarded as the most economic and efficient prime mover. The Price oil engine is to all intents and purposes a Diesel engine, but with the air compressor eliminated, which results in a saving of ten to twelve per cent. in mechanical efficiency. It is claimed that .38 or .39 lb. of fuel per brake horsepower can be easily attained, the former figure meaning 20 h.p.-hours from a gallon of standard fuel. The makers also guarantee that the engine will deliver 4,000 h.p.-hours per gallon of lubricating oil, every possible mechanical precaution being taken to prevent the waste of oil. The engine operates on a 4-stroke cycle and the exhaust and intake valves are actuated by push rods from cams. The cams are housed in a compartment case in the engine frame, which protects them from injury and permits keeping them flooded with lubricating oil.

The company has lost no time in putting on the market one of these engines direct connected to an air compressor. This unit consists of a 100 h.p. engine with the air cylinder in line with the power cylinder but on the opposite side of the crankshaft. For 100 lbs. pressure a two-stage air cylinder is offered. The air intercooler is mounted below the air cylinder and forms a support for it. For air



INGERSOLL-RAND AIR COMPRESSOR

pressure less than 100 lbs. a single-stage cylinder is offered. For both single and two-stage work the air cylinder is double-acting. In the 50 h.p. size the air cylinder is vertical and is mounted on top of the engine immediately above the crankshaft. This construction makes it possible to mount the unit on a flat car or truck for use in portable work. The total height, however, is less than 8½ feet. The Price engine has also been direct connected to an ammonia compressor unit, of which two sizes are now being made, the larger having an actual delivered capacity of gas equivalent to 63 tons of refrigeration and the smaller having half this capacity. The manufacturers claim that, even allowing for greater firstcost, air can be compressed with fuel oil at 6c. per gallon on a par with electric power at 1¼c. per k.w.h., while with fuel at 12c. a gallon the equivalent cost of electric power is 1½c.

Official Conclusions From the Bates Road

Which may, in the opinion of Clifford Older, chief engineer of the Illinois Division of Highways, be safely drawn from this test.

Clifford Older, chief highway engineer of the Illinois Division of Highways, presented to the American Association of State Highway Officials, at its annual meeting in December, an official statement of the conclusions that "may safely be drawn from the general behavior of the Bates Road." The two outstanding conclusions he gives as: "First, the load-carrying capacity of any design of rigid pavement slab is in direct proportion to the ability of its weakest part to resist bending stresses."

Second: "Rigid pavements having a uniform thickness or edges thinner than the center are greatly unbalanced in strength and will fail along the edges long before wheel loads are reached that would cause the destruction of other portions of the slab."

Commenting upon the first, he said that under fixed conditions pavements of definite thickness will carry certain wheel loads indefinitely, but a considerable number of somewhat heavier loads will result in numerous corner breaks, while still heavier loads may quickly result in complete destruction. It follows that pavements cannot be constructed that will not be utterly destroyed in a few months or years if the wheel loads are not rigidly controlled. This control must be had by a state police force, and only such a force can prevent the early destruction of any road that it is practicable to construct.

Commenting upon the second conclusion, Mr. Older stated that "although fifty of the original sixty-three sections of the Bates Road were either partially or completely destroyed, not one case of serious partial or complete destruction of a rigid section occurred that was not directly due to the lengthening and widening of one or more small broken corner areas. . . . There is much evidence to support the belief that had all of the traffic been not closer than three feet to either edge, even the 4-inch slabs would still be intact. Increasing the edge strength of pavements of ordinary width should, therefore, be of first importance in design."

Concerning the effect of richness of mix, he states that two mixes were used, both with practically the same ratio of sand to stone, but one with half as much cement as sand and the other with one-third as much. "While most of the engineers, who were in constant touch with the test during its progress, believe they can trace a showing in favor of the rich mix, yet the difference is by no means marked." He concludes that "leaner mixes with increased thickness to compensate for strength loss may be an economic development under certain conditions."

He then discussed the results as classified by types of pavement. Concerning brick wearing surface with bituminous joint filler on waterbound macadam base, the destruction of this type consisted of rutting in the wheel tracks until the sections were unfit for traffic. In the case of asphaltic concrete on waterbound macadam base, there seemed to be "no consistent relation between load-carrying capacity and thickness of base" or of top. He stated that "practically all visitors agree that the soil and subgrade condition was as nearly uniform as ever occurs."

Mr. Older then discussed the data obtained from this test in its bearing on the assumption that the corners of rigid pavements or bases should be designed as unsupported cantilevers. Incidentally he stated that "the assumption made, when the test sections were originally laid out, that the bituminous-top pavements would have a strength equal to the strength of the base if the same were increased by one inch is only partially borne out. . . . It would appear that an allowance equal to one-

quarter of the top thickness is fully as much as would be justified." However, critical corner failures in such pavements were not in many cases followed by immediate breaking-down of large areas as in some other rigid types.

In December, 1920, Mr. Older suggested a tentative formula for pavement design based on the assumption that the corners of slabs should be designed as unsupported cantilevers. This theory was used as a basis for studying the results of the Bates tests, the formula for slabs of ordinary design being

$$W \text{ equals } \frac{Sd^2}{3},$$

in which W is the breaking load, d is the depth of slab and S the modulus of rupture of the concrete or other load-carrying element. Mr. Older plotted points having the breaking load as ordinates, and the base thickness as abscissas, on the basis of this formula he plotted curves using values of S to fit most approximately each class of pavement. The curves fitted to these several cases gave values of S of 706 for Topeka top on concrete base; 631 for monolithic brick assuming the pavement acted as two concrete layers having the thickness of the base and the top respectively; 726 for all concrete sections, and 733 with the omission of those sections containing calcium chloride and cemite cement, which had distinctly lower modulus of rupture than the other sections. In the results for the remaining concrete sections, which included plain concrete, those containing wire mesh and one containing hydrated lime, the actual and theoretical loads showed a surprising conformity.

In general, Mr. Older concludes that the test, using the load which caused the first corner breaking as a basis, corresponded very closely to the theoretical breaking load on the cantilever basis. An apparent exception was the monolithic brick pavements if the assumption was made that the total thickness of the pavement acted as a unit. It was observed that at many points the brick surface separated distinctly from the base, and it was noted that at many critical points the base and the brick top acted as independent units.

The fatigue tests which have been carried on by this department for about eighteen months "indicate conclusively that concrete may resist bending loads indefinitely if such loads do not cause fibre stresses in excess of one-half of the modulus of rupture of the concrete. Inasmuch as it was impossible to operate the trucks a sufficient number of trips for each increment to cause fatigue, the plotted points in all diagrams without doubt are but little affected by fatigue breakage. The laboratory tests show that where the loads applied, produced a fibre stress of from 5 to 10 per cent. in excess of one-half of the modulus of rupture, fatigue may not follow for from 5,000 to 40,000 repetitions. Loads which produce fibre stresses in excess of 60 per cent. of the modulus of rupture are usually followed by breakage after a comparatively few repetitions.

"It seems safe, therefore, to conclude that had the number of applications of each increment been much greater—say 30,000 to 40,000—we would have the breaking load points falling, in the main, between the curve passing through points representing a fibre stress of 703 and that representing a fibre stress of 351."

From these results Mr. Older concludes that, while the theory on which the above formula was based "is, perhaps, not yet fully established, nevertheless, the empirical data furnished by the traffic tests seem to be sufficiently confirmatory to justify its use at least until something better is found."

"By means of one or more continuous dowel bars along the edge, it is believed that adjacent corners may be made to act together and thus the breaking and working loads may be increased materially, or, perhaps, even doubled. Further, it is easily conceivable that if in addition to dowel bars the edges are thickened, they may be made stronger than other portions of the slab. It is, then, important to determine where next to look for trouble; and eventually determine how the slab should be designed for balanced strength throughout."

The behavior of the test section shows that loads much in excess of the critical load, as determined by the theoretical curve, are almost sure quickly to cause extremely serious progressive destruction.

It would seem difficult to eliminate the danger entirely. It is suggested that shoulders of gravel, macadam, concrete or other material which could be constantly maintained, preferably slightly higher than the permanent edge, would help. Such shoulders would ordinarily prevent wheel loads from being applied to the extreme edges of the slab and thus tend to reduce bending stresses. Center traffic lines also help because where such lines exist drivers concern themselves only with keeping their vehicles on the proper side of the line. Without such lines they crowd to the outer edge of the pavement in order to make sure to clear passing vehicles.

Heavy triangular corner repairs or rigid material will also help, as the obtuse angled corners of the adjacent old slab will carry greater loads than right-angled corners.

Limiting the loads to the strength of the slab would solve the problem for the old pavement.

Designs for new pavements should undoubtedly provide for strengthened edges.

This may be accomplished by providing integral curbs which would not only strengthen the edge but largely prevent wheel loads from being applied to the extreme edge. It is believed that wider pavements with integral or inverted curbs, using no more or even less material than is now used in many designs, would afford equal or possibly greater load carrying capacity.

Merely increasing the width would undoubtedly prolong the life by reducing the frequency of the passing of heavy wheel loads off and on, and along the edges.

Longitudinal joints in concrete pavements reduce the warping due to changes of temperature, thus increasing the possibility of subgrade support along the edges under night traffic. Such joints should be provided with tie bars to prevent spreading, and a corrugated or tongue and groove effect, so that the adjacent slabs would afford mutual support.

Mr. Older then described the new Illinois design with the thickened edge, which has already been described twice in "Public Works." Four sections of this type have been added to the Bates Road, and will be tested by truck traffic early next spring.

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Labor and Immigration

Unless the three per cent Immigration Law is radically changed, construction and manufacturing in this country must, it would seem, suffer a serious setback and wages increase beyond reason. Some restriction on immigration is probably desirable, but this law seems to us to provide few desirable restrictions and many undesirable ones. For example, last year only 42,000 Italian immigrants were allowed to enter the country, but 53,000 left it, causing an actual decrease of 11,000 in a class of immigrants upon whom the East relies largely for its labor.

A beneficial law should provide for making up such deficits in any given nationality or, better still, in any class or type of labor in which a shortage may temporarily be found to exist. Moreover, all concerned would be benefited if the weeding-out be made at the ports of embarkation instead of in this country. The burden of proof should be placed on the immigrant to show that he is desirable for our needs, for immigration to this country is a privilege, not a right. Physical, moral and political tests should be prescribed, and applied to each would-be immigrant by competent United States officials in the several foreign countries or points of assemblage for embarkation.

Labor depletion under this law has already begun to produce its effects, and will become a serious matter when we get into full swing—or endeavor to —in our efforts to make up for lost time in public works, railroad work and other lines of construction that were interrupted by the war.

The National Association of Manufacturers a few days ago announced a program of immigration legislation to be presented to Congress, which contractors and others interested in public works might well endorse. The Association advocates fixing a quota in terms of net immigration, authorizing the Secretary of Labor to use his judgment in admitting beyond the quota if shortage of any class of labor be shown, eliminating the literacy test, more stringent requirements for naturalization, exercising the right of registering, distributing and educating the aliens meantime, and that all features of immigration regulation be controlled through a board composed of the Secretaries of Agriculture, Commerce and Labor. The need for some changes in the law certainly seems to be imperative.

Unfortunate Limitation of Borrowing Power

An opinion rendered by the City Solicitor of Philadelphia has not only produced a decided shock among the administrators of that city, but the general principle involved is, in our opinion, a most unfortunate one to impose upon any city. In brief, this is that the total cost of a complete municipal improvement which has as yet been undertaken in part only becomes immediately a charge against the borrowing capacity of the city, even though a large part of the expenditure may not be made for many years to come. It is of course very desirable that restraint be placed upon city officials to prevent their committing the city to extravagant expenditures, and the law placing a limit upon the amount of

money that can be borrowed by city bonds is a wise one. As a matter of fact, if the state laws themselves did not place such a limit, one would be placed by the financiers in refusing to take a city's bonds after they had reached a certain total. This is indicated by the fact that, although the New Jersey State laws assign a higher percentage of a city's assessed valuation as its bond limit than do the laws of New York State, some New Jersey municipalities find it wise to confine their indebtedness within the New York rather than the New Jersey limits because they wish to float their bonds in the former state, through New York City bankers.

This, however, is an entirely different matter from including, in the issues so limited, bonds that may not be required until ten or twenty years hence to complete a project which is only being begun in the present. We fear that the effect of the general adoption of such a ruling would be to return the cities to the condition of years ago when public work was done piecemeal rather than as parts of a comprehensive plan prepared to secure systematic construction extending over as long a period as might be necessary to complete the entire program. City planning and all that is involved in it might be seriously interfered with. For instance, it has been stated that the constructing of any of the several sewage treatment plants proposed for Philadelphia will be held up until the city's finances reach the point where they will permit providing, within the bond limit, of a sufficient sum to finance *all* of the plants which it is proposed to build during the next ten to twenty years.

There certainly can be found some middle course between this ruling and extravagance which will sufficiently safeguard the taxpayers and the investors in the city's bonds, without compelling a return to the unco-ordinated construction of public works which was unfortunately the practice a generation ago.

The Bates Road Tests

Comments on the Bates road tests conducted by the Illinois Bureau of Highways, as expressed by Will P. Blair, vice-president of the National Paving Brick Manufacturers Association, have recently been made public. In his comments, after describing the various sections of the road and the tests made, Mr. Blair discusses various features of the test and draws the conclusion that "with all the official information before us respecting the Bates road experiment and the light gained from actual observation, we do insist that with so many factors left out of consideration, there is little that can be relied upon as a guide to a preferential road construction."

His chief reason for this conclusion appears to be that, while the promoters of the road assumed that it was placed on a uniform condition of soil and every effort made to secure uniformity throughout, no such uniformity actually existed. In some places water oozing from the sub-soil beneath the road deposited a film of sand in the bottom of side ditches, while at other points no sand was in evidence whatever and it was believed that no sand was present. As to water content, the official observers reported that the supply of moisture in the subgrade varied intermittently from zero to forty per cent. In some places the subsoil was so saturated that the vibration of the pavement under traffic could readily be witnessed by the eye, water even being thrown from the edge of the pavement with considerable force by the traffic.

Day by day in every way it became evident that no two sections of the entire two miles of pavement were alike in bearing power of the soil. This being the case, it could not be claimed, Mr. Blair maintains, that any result of any one section of withstanding or failure to withstand the traffic imposed formed any criterion for comparing the durability or other value of that section as compared with the others.

As further evidence of this, the official reports themselves point to certain inconsistencies, which would naturally be expected from this non-uniformity of sub-base. For instance, the official statement contains the words: "No consistent ratio of strength to thickness of base appears," since a 6-inch base at one point did not become badly damaged until after the fourth increment, while an 8-inch base yielded under the second increment. Mr. Blair remarks: "Other inconsistencies are mentioned in sufficient numbers to entirely break down the values observed as consistent." In fact, it appears to him that phenomena classed as consistencies on the assumption of a uniform sub-base really need more explanation than do those classed as inconsistencies.

Moving Construction Track Bodily

In building a 12-mile section of concrete pavement last year (which, by the way, he accomplished with a single mixer) C. M. Kirkpatrick of Greenfield, Indiana, introduced at least one novel method. This was the moving bodily of a 300-foot section of 24-inch gauge track whenever the mixer was moved, this being the track over which the aggregate was brought to the mixer.

An interurban railroad paralleled the pavement and the cement, sand and pebbles used for the concrete were delivered by this, the cement being unloaded from cars directly to wooden platforms and the aggregates being brought in 12-yd. side-dump cars and dumped alongside the railway. After being dumped, the aggregates were distributed by means of a scraper to form a continuous winrow or stock pile parallel to the track. The 300-foot 24-inch gauge track referred to was laid paralleling the interurban railway, located near the center of the subgrade and just ahead of the mixer. Two Barber-Greene portable bucket loaders were used for loading sand and pebbles into motor trucks mounted on flanged wheels which traveled on this track and dumped directly into the mixer hopper. Each of these motor trucks carried a wooden box with a hinged door at the back, the bottom of the hopper sloping downward toward the rear. A short hinged

section of track extended over the edge of the skip to permit dumping directly into the skip, and folded back when the skip was raised.

The track was mounted on continuous wooden supports under each rail and made up of a 1x6-inch strip underneath a 2x6-inch. Whenever the mixer was moved ahead, the entire section of track was pulled forward the same distance by means of a cable and two capstans which were rented from a house-mover, each capstan being operated by a horse. The cable passed through a pulley fastened to the track and each end of the cable was attached to a capstan. By using the two capstans the moving was done in half the time that would be required with one only. At first a 500-ft. section of track was used, but this was reduced to 300 feet.

The mixer was a Koehring 21-E paver. A Lakewood tamper carried on heavy Heltzel forms was used in finishing. The pavement was covered with burlap and wet straw was placed on top of this to protect the concrete during the curing period.

During July the contractor averaged 600 feet of pavement 18 ft. wide and 7-8-7 inches thick, with a maximum day's run of 743 ft. in 10 hours. It is believed that this was the record for Indiana for the year 1922.

Concrete Road Finishing Machines

By G. Maxon, Jr.

The past year has seen considerable advance in labor-saving devices for striking off and compacting concrete. In discussing the subject, it is probably best to divide the field into two, if not three classes.

Jobs where the concrete is mixed wet and the aggregate contains considerable excess mortar are thought of as unfavorable to the use of a machine. This sort of concrete can be handled without the aid of a machine and excessive tamping tends to raise too great a quantity of mortar to the surface, and consequently water-holes appear after the initial set. Wherever mixes of this sort are preferred, it is very essential that but little tamping should be done, and a transverse roller be used to remove the excess moisture and to eliminate water-holes. It is expedient, if a machine is used, to have one on this kind of work that strikes off with extreme accuracy. There are two machines now on the market which have the strike-off working directly on the rail and which have the required degree of accuracy. One of these machines at the present time is too heavy for ordinary road-forms, but the quality of work it does with a wet mix and where there is an excess of mortar cannot be improved upon. We suggest that, where the strike-off alone is used, considerable spading be done inside the forms, otherwise the road will be porous along the sides.

Mediumly dry mixes, particularly where no great amount of excess mortar is provided, must be compacted by tamping. It is most essential that concrete of this sort be free from voids, in order to realize the greater possible strength of such a mixture than that of a wet mix. The other essential feature in producing the best possible quality of road with this type of mix is accurate striking off. If the machine used does not strike off accurately, considerable skill and experience on the part of the spreaders in producing an even surface is necessary.

Very dry concrete requires repeated tamping and considerable retouching, regardless of the machine used. It is most desirable that if a machine be used that has an accurate strike-off, that member be used together with the tamper whenever the machine is moving forward. If this striking member has a smooth bottom, it can bring the surface to crown and elevation with two or three applications, but if the strike-board has a knife-edge, it will tear up the concrete which has been partially put in place by the tamper.

A machine experimented with last year places the concrete by means of a roller. This roller is supposed to strike off and compact the concrete. With wet mixes the hydrostatic head of the concrete in front of the roller will cause it to bulge up in the rear. With dry mixes, this roller, which rotates in the opposite direction to which it is traveling, will tear out the larger aggregate and leave no end of voids, particularly where the road-slab is thin. It is a well known fact to those who have finished concrete in any shape, that in troweling, but little weight can be used on the concrete before it has reached its initial set, and this roller trowels and applies weight.

Devices which propose to eliminate tamping may be practical where the concrete is quite wet, but there can be no question as to the necessity of tamping in very dry mixes. It is the only practical means of completely eliminating voids and should always be done until both the air and the excess water are brought to the surface for removal.

Machines for placing concrete roads should have a certain amount of excess power and the very best of material should be used, for the reason that their weight is limited and the strains and vibrations on a machine which spans the entire road and strikes off concrete are greater than one might imagine. The contractor should be very careful not to choose a machine that has too much weight. There is no road form made at the present time that will stand up any length of time with a load of more than twelve hundred pounds on any one wheel. The front wheels of all machines approach this limit, and there are a few machines where practically eighty per cent. of the weight is carried on the front journals and which ultimately destroy the rail.

Other features to be considered are the accessibility of parts, ease of operation and speed. Referring to this latter consideration, there are places where two finishing machines are required. If there is not already on the market a machine that can handle twelve or fourteen hundred lineal feet of concrete road in a day, one should be developed.

Considering machines in general, every job of five miles or more should be finished by machine. Whatever the nature of mix, a machine is obtainable which, when properly operated, can produce a better surface and a better road than the most skilled hand-work, and do the same with a distinct saving to the contractor, particularly where four hundred feet or more is laid within one working day.

Recent Developments in Sewage Treatment

Review of development of skimming tanks, fine screens, Imhoff tanks, separate sludge digestion, continuous sludge removal, contact beds, activated sludge, and the Maclachlan process.

In a paper with the above title read before the American Society for Municipal Improvements, George W. Fuller summed up briefly some of the recent developments and newer systems.

Skimming tanks. Under this head he referred to the Toledo plant where the skimming tank now under construction will receive sewage after it has passed through cage screens, the sewage so entering the tank as to have a circulatory movement which causes an eddying effect so that the floating materials will rise to the surface, allowing grease to become attached to corks and other solid matters which will be skimmed from the surface from time to time. This device, he says, is closely similar to the skimming tank at Washington, D. C., which has been so successful in eliminating floating matters from the submerged outlets in the Potomac river.

Fine screening. Fine screens have been recommended at Los Angeles and additional ones for sewers discharging into New York Harbor. Probably the largest are those to be used in connection with activated sludge plants at Milwaukee, Indianapolis and Chicago. The Riensch-Wurl screen has now as competitors less expensive ones such as the Dorr, installed at New Britain, Connecticut, and Bethlehem, Pa.; the Link Belt screen at Pleasantville, New Jersey, and the Rex screen developed at Milwaukee by the Chain Belt Company; while the last-named company is building a drum screen at Indianapolis designed by Mr. Hurd.

The screenings at the Dyckman Street plant in New York are barged to sea by the Street Cleaning Department; at Rochester they are dumped and covered with material removed from the grit chamber; at New Britain they are hauled to an isolated site and dumped; at Plainfield, N. J., they are at once plowed into the land, and at Long Beach, Calif., they were burned in an oil-fed incinerator.

Imhoff or two-story tanks. During the past ten years the tendency has been to make the flowing-through compartments smaller and the sludge storage compartments and sludge beds larger than formerly. The flowing-through compartment is ordinarily made from seventy to ninety feet long with linear velocities not exceeding 1.5 to 2 feet per minute. The vents should occupy about 20% of the total area of the tanks. It is not safe to figure on less than 90% of water in the sludge in the lower compartment, and it has frequently reached 93% to 96% at Plainfield, N. J., and York, Pa. Designs were formerly based on about 85% water content, for which reason the capacity of this compartment should be 50% to 100% larger than in earlier designs. In the northern states the sludge storage should be on a per capita basis of 1.7 to 2 cubic feet per capita. In the extreme northern part of the country it may be desirable to increase this by 50%, while in southern climates it may be reduced somewhat. The area of sludge beds, instead of being one-third square foot per capita, should, Mr. Fuller believes, be at least three-quarters of a square foot in the northern states, and one square foot where combined sewers are used.

Separate sludge digestion tanks. Under this head the author gave briefly information concerning the Baltimore tanks which were described at some length in Public Works for August.

Somewhat similar is the use of single-story tanks such as septic tanks in rotation. At Plainfield and Morristown, N. J., and Washington, Pa., the plan was tried of allowing sewage to flow through one tank until the effluent contained objectionable quantities of suspended matter; then putting this tank out of service and using a second tank, and then a third tank; the first tank meantime being allowed to stand and the sludge digest. The results were fairly satisfactory in each case until the tanks became overtaxed. He believes that such tanks should be built in five or more compartments with a total capacity of eighteen to twenty-four hours of average sewage flow.

Continuous sludge removal. At Syracuse, N. Y., extensive tests have been made with sedimentation tanks arranged with scrapers working along the bottom of the tanks from the outlet toward the inlet end. It was found that the velocity of flow should not exceed about 1.75 feet per minute and that the detention period need not be more than about three-quarters of an hour. About 60 per cent. of the suspended matter was removed under these conditions and comparatively little increase was obtained by a longer detention period or lower velocity. Continuous removal of the sludge prevents the formation of gas and of gas-lifted floating sludge. Floating matters are retained by scum boards. Solids removed from the floor of the tank by the scrapers will be mixed with wastes from the Solvay Process Company.

At Indianapolis "concentrate thickener tanks" have been designed, there being four, each fifteen feet wide at the top and about 120 feet long. The floors of these tanks will be scraped by scrapers moving from the outlet toward the inlet at a speed of not more than five feet per minute. These tanks will receive the solids rejected by the screens and their effluent may be sent to the river or pumped to the influent of the aerated tanks of the activated sludge process. The sludge from the thickener tanks will be mixed with the settled sludge coming from the activated sludge process and the resulting mixture dewatered.

Contact beds and trickling filters. Ordinarily contact beds are not so economical as trickling filters, but have a distinct field of usefulness for some small plants, in that they do not call for so great isolation as trickling filters, because they do not disseminate odors by spraying, nor are they subject to the fly nuisance. They also require a smaller head than is needed for sprinkling filters. There is some advantage in the use of these followed by sand filters where a high degree of purification is desired.

Trickling filters have probably been more successful in bringing about a practical accomplishment of what was originally expected of them than any other single group of sewage treatment devices. Such filters have been in use twelve or more years in this country and twenty to twenty-five years in England without needing cleaning. The three points given special attention are odor, plant loading, and control of flies. Odors are generally caused by the spraying of septic sewage, whether from septic tanks or sewage which has become stale in sewers. Nozzle clogging seems to be more or less inevitable. Even where the sewage as it reaches the filter contains no suspended matter, there will be intermittent detachment of accumulations of fine suspended particles that adhere to the inside of the distribution system. However, fine screens can keep this within reasonable control.

With ordinary six-foot beds, a rate of 2,000,000 gallons per acre per day is by no means excessive. Non-putrecible effluent may be obtained at rates 20% in excess of this, especially if the beds be made somewhat deeper and if the nozzle spacing and heads be such as to secure more uniform distribution over the surface than is found in a number of plants. In some southern climates filter loadings up to 3,000,000 gallons per acre have been found feasible.

These figures refer to sewage that has been settled. If the sewage is only passed through fine screens, the rate will be considerably less.

Concerning flies, Mr. Fuller stated that these are found in the upper layers of most but not all trickling filters and described the method of preventing them by drowning the larvae and pupae by flooding the filters at intervals of ten days, as has been described in Public Works.

Activated sludge process. Operating experiences show that this process can turn out regularly a clear, non-putrescible effluent from which 90% to 98% of the bacteria in the raw sewage have been eliminated. Questions as to the practicability of the process relate to economies of sludge handling and to the cost of construction and operation.

With the drop in the value of fertilizer there seems little chance of selling sludge for this purpose and present efforts should be devoted to minimizing the cost of sludge handling. At Houston activated sludge is delivered from settling tanks into lagoons and allowed to accumulate there year after year without producing a nuisance. For the north side of Chicago, Messrs. Eddy, Hatton and Fuller recommended delivering activated sludge without dewatering through a pipe line to waste lands between the Desplaines river levee and the main drainage channel, until such time as a drying operation has been perfected, the cost of which will not exceed the proceeds to be derived from the sale of the sludge as fertilizer. Possibilities for sludge-lagooning are of course not always to be found. In fact, at the north-side plant in Houston difficulty in finding land for the purpose has led the city to consider various means of dewatering the sludge.

The Maclachlan process was described by Mr. Fuller and the plant at Gastonia (see Public Works for March 4th). In the plant at Houston the sludge is passed through a cylindrical inward-flow drum screen covered with sixty-mesh brass wire cloth revolving about two-thirds submerged in a vat through which sludge treated by this process flows continuously. The sludge builds up a sheet of material which holds back the finer particles and as the screen emerges from the water this sheet of sludge is picked up on a traveling felt belt similar to the wet machine used in the paper industry. The belt and sludge are passed through squeezing rollers where some of the water is pressed out and the sludge then leaves the belt in a thin sheet which has a water content of about 80%. The cost of this dewatering at Houston was said to be from $5 to $7 per ton of dry solids.

Final tanks. In all oxidizing processes other than sand beds it is necessary to settle the effluent. The present tendency is definitely toward removing the sludge from such settling tanks at fairly frequent intervals, if not continuously, by the aid the Dorr thickeners, which facilitate the delivery to a sump of the solids deposited on the floor of the tank.

Direct oxidation. Mr. Fuller finally gave at some length a description of the electrolytic or direct oxidation process, the discussion of which in his paper and by others has already been presented in these pages.

South Carolina Electric Power Plants

The Southern Power Company has announced that its ambitious construction program begun in 1922 and estimated to cost sixteen million dollars will be completed in 1923. The plans include two hydro-electric plants, one at Mountain Island in North Carolina and the other at Great Falls, S. C., both on the Catawba River. The former will develop 80,000 h.p. and the latter 60,000 h.p.

Separate or Combined Sewers

Advantages of each discussed and an illustration of the comparative cost of each for a specific case.

In a paper before the American Society for Municipal Improvements discussing the abuse of separate sewers and storm water drains, Harrison P. Eddy presented figures obtained from actual bids applied to alternative designs for a specific case, thus affording an unusual opportunity for comparing costs of the different systems. This part of his paper is given below:

The construction of a system of separate sewers without a system of storm drains, or with only a partial one, has become common practice in small communities and is somewhat prevalent in the larger cities. This has been based generally on economic necessity, either real or fancied as the case may have been. As it is rather unusual to make complete accurate estimates of cost of the two systems under consideration it may add interest to illustrate the subject by a case in which three plans were designed complete and estimates of cost of all three systems were based upon the lowest bid of contractors upon one of the systems. The six proposals were received under the unit price form of contract and were capable of application with a good degree of accuracy to the other two plans upon which bids were not invited.

The sewer district comprised an area of 305 acres. The topography was such that the sewers could be provided with good slopes. Sewers were designed to serve all building lots, and in the case of the partial system of storm drains the drains were provided to serve all the inlets required for proper drainage of the streets, without allowing water to flow across street intersections. The drainage system so built would accommodate 70 per cent. of the houses of the entire tract. The ultimate complete development of this district will provide about 7.4 building lots per acre of gross area (including streets). This is equivalent to a total of 2,257 lots. In some cases the sewer and the storm drain connections will be in the same trench in the streets and a portion of the private premises; in others, they will be mostly in different trenches. In many cases the roof leaders will connect with pipes laid outside the buildings, but in some instances they will connect with iron pipes in the cellars. In the estimate which follows the allowances for the house connections are such as to cover, on the average, the several conditions described.

In this illustration the sewers and storm drains were designed to be built in separate trenches except where the drains were 30 inches or more in size. Some reduction in cost might result from putting both pipes in one trench in all cases.

A comparison of costs should include the cost to property owners of the work which they will be required to do, such as the making of duplicate connections, and where drains are not provided the placing of pavement around buildings to receive the drip from eaves and the carrying of roof water pipes under lawns and sidewalks to gutters. In the following estimates, however, only the estimated cost of house connections extending from the common sewers and drains to the soil pipes and roof leaders has been added to the estimated cost of the common sewers and drains. The estimates of cost of the three projects are given in the table.

Estimate of Cost of Sewers, Storm Drains and House Connections—1920.

Type of System	Cost of Sewers or Sewers and Drains	Cost of House Connections Work in Streets	Work in Private Property	Total Cost
Combined sewers	$476,625 (72.7%)	$56,425 (8.6%)	$122,600 (18.7%)	$655,650 (100%)
Separate sewers and partial system of storm drains	477,700 (68.7%)	80,125 (11.6%)	140,900 (19.7%)	698,725 (100%)
Separate sewers and complete system of storm drains	524,850 (67.2%)	90,280 (11.6%)	164,900 (21.2%)	780,030 (100%)

The estimates indicate that under the conditions of this case the combined system would be substantially cheaper than the system of separate sewers and a partial or incomplete system of storm drains, and considerably less expensive than the complete systems of separate sewers and storm drains. Of the total expenditure approximately 30 per cent. is required for house connections and drains around the houses to collect roof water. About two-thirds of this amount is for work in private property.

Such estimates are open to attack on a number of grounds. It is seldom that all abutting lots are built upon at the outset. An adjustment in costs might therefore be made on account of saving in interest. More important would be the probable saving due to the postponement of construction of some of the drains. The estimate therefore is applicable only to this specific case and is used merely to illustrate general tendencies.

Sedgwick Lecture on Public Health

For the purpose of commemorating the services of William Thompson Sedgwick, professor in the Massachusetts Institute of Technology, to the cause of biology and public health, a memorial lectureship has been established to the end that there shall be given each year by men of eminence in subjects comprehended within the general scope of biology and public health, lectures on different phases of those subjects. The first lecture was given in Huntington Hall, Boston, on Friday, December 29th, by Edmund

Beecher Wilson, daCosta professor of zoology, Columbia University, the subject being, "The Physical Basis of Life." The lecture was free to the public.

Water Works Superintendents and Fire Fighting

Their responsibility for the service rendered by the water department in minimizing fire losses.

The assistant to the chief engineer of the Southeastern Underwriters Association, W. T. Cates, presented at the annual meeting of the North Carolina Section of the American Water Works Association a paper entitled, "The Water Works Superintendent's Responsibility for Fire Fighting," in which he aimed to enlist the interest of water works superintendents in a greater appreciation of their responsibilities in this respect.

He referred to the "grading schedule" of the Underwriters Association in which, of the 5,000 points of total deficiency used in grading cities on the basis of probability of fire loss, water supply is assigned 34%, the fire department 30%, fire alarm 11%, structural conditions 14%, and the police, building laws, and hazards the remaining 11%. This shows that the fire underwriters consider the condition of the water supply to be more important even than the fire department.

The subject of water supply is divided in the schedule into various items, important among which are the selection and retention of officials and employees and the qualification of the superintendent; selection under civil service being considered desirable and long retention of efficient superintendents and employees.

Mr. Cates considered the inspection of valves and hydrants most important. "Broken valve stems with the valve left closed on some supply line, or hydrants with damaged valves or worn threads on the outlets, have often meant failure to obtain a prompt supply of water and consequent heavy damage to valuable buildings and contents." He cited one city where, although the plan of the distribution system indicated that a certain section should have good water protection, a test of the fire hydrants showed that it did not and it was rated accordingly. Some years later a neglected and overlooked partially closed valve in the main was found, and upon opening this valve the necessary supply and pressure were obtained.

Because the use of hydrants by sprinkler carts has caused nuts or valve stems and valves to be so worn as to be at times unoperative, and the threads on outlets so worn that under high pressure the hose coupling has been blown off the hydrant, he urgently recommended that special hydrants for use by sprinkler carts be provided and use of regular fire hydrants by them be prohibited. He also recommended that valves be thoroughly inspected and that only those turning in one direction be permitted to remain in any system.

Finally, he outlined the more important items under eleven heads. The first was: Complete records, plans and maps of the physical structures and operation of the system. Second: Emergency crews with wagon loaded with the necessary tools in the larger cities, and some one responsible employee in the smaller cities, to respond to all alarms in the mercantile district and on call elsewhere. Third: Some method for notifying the superintendent or some responsible employee of an alarm of fire. If pressure is to be raised or pumps speeded up, the pumping station should be notified of an alarm and also when the fire has been extinguished. Fourth: The superintendent is responsible for the extensions of the system and should insure that they have sufficient capacity and also that the source of supply should be increased when necessary as well as the storage capacity, and that pumps, compressors, boilers and motors should be kept in condition to supply full capacity at all times. Fifth: At least five days' supply of fuel should be in reserve at the station under normal conditions, and even more under abnormal conditions such as long hauls, bad roads, etc. The station itself should be well protected from fire. Sixth: In making extensions no pipes smaller than six inches should be used. Seventh: Dead ends in mains should be avoided where possible; if used, the size of pipe should give a capacity at least that of a 6-inch loop. Eighth: Pipes used should have the strength provided by the specifications of the American Water Works Association. Ninth: There should be sufficient gate valves to control each 500 feet of pipe in the mercantile district and not more than 800 feet in other sections. All valves should be inspected at least once a year and kept in good condition at all times. Tenth: The hydrant outlets should be sufficient in number "to discharge two-thirds of the required flow about any block or group of buildings in the mercantile, manufacturing and warehouse districts, and five hundred gallons or more in other districts." Every hydrant should be inspected at least twice a year, after fires, and oftener if necessary to maintain them in good condition. Eleventh: Full cooperation should be maintained between the water works superintendent and the chief of the fire department.

Public Improvements in Denver

During the closing months of 1922 the city administration in Denver inaugurated new improvement projects totaling more than $1,673,000, in addition to new storm sewers contemplated at a cost of about a million dollars and a considerable amount of other work. The improvements include sewers in a number of districts, paving and other work, which bring the total public improvements to be completed in 1923 up to a total of nearly $3,700,000, or twice as much as has ever been done in one year in the history of the city. During 1922 the total amount expended was $832,350.

Terms for Water Works Bonds

Conclusions of Charles W. Sherman concerning average life, depreciation, residual value, and, based thereon, the term for which water works bonds should be issued.

Under the title, "The Proper Term for Which Water Works Bonds Should Run," Charles W. Sherman of the engineering firm of Metcalf and Eddy read a paper before the New England Water Works Association giving a quite thorough discussion of this subject. He first considered the life of each of the different features of a water works plant and then considered the remaining life of a plant which had been built in a number of installments, as the basis for the term of bonds to be issued with the plant as security. He gave special consideration to the Massachusetts laws on the subject and described in detail as an illustration the present situation at Belmont, Massachusetts.

The paper is too long to permit reproduction in this journal and at the same time is so concisely stated that it does not seem practicable to give an abstract, but the author's conclusions, summarizing the paper, are as follows:

"1. The average life for a 'typical' water works plant in this country is about 50 years. It will rarely be less than this in individual cases, and may be as much as 60 years or more for some works.

"2. Complete records of depreciation, including abandoned structures, of a number of water works plants of considerable age show that the total accrued depreciation of the physical plant of such works is about 20% of the cost. Departures from this mean are not great. Records of depreciation suffered by the plant still in service, modified by a suitable allowance for plant abandoned, confirm this as a reasonable normal figure.

"3. The corresponding average age for works of 50 years' life is 20 years, leaving 30 years average remaining life. If the average useful life were 60 years instead of 50, the average age would be 27 years and the remaining life 33 years. Thirty years is a fair estimate of the average remaining life of any water works plant in normal condition, and therefore a proper term for which water works bonds should run.

"4. If the works have suffered a depreciation of 20%, including abandoned property, there is a residual value of 80% of cost of the physical plant. Water works bonds may therefore safely be issued up to 80% of the normal cost of the works.

"5. Municipally owned water works should be self-supporting and their financing should be on the same general basis as that of private corporations.

"6. The clause of the present Massachusetts law which limits bonds for the extension of municipally owned water works to a term of 5 years is illogical and burdensome, and should be repealed.

"7. Special legislation for particular cases, made necessary by the existence of the 5-year limit, is undesirable from every point of view.

"8. Suitable control over municipal bonds for water works purposes can be exercised by requiring the approval of the Public Utilities Commissioners in exactly the same way as for bonds of a private water company.

"9. Misuse of water revenues can be avoided by legislation limiting their uses to water works purposes."

The Use of Filter Re-Wash*

By J. H. Suggs†

Too rapid admission of re-wash water gives objectionable results. Remedies proposed.

My subject, "The Use of Filter Re-wash," should perhaps be more properly entitled "The Abuse of the Filter Re-wash."

When a filter is first washed we all know that the effluent for the first few minutes of operation of the filter is not of a satisfactory quality, the quality depending largely upon how thoroughly we have washed the filter.

In a large filter plant with a great many units which are not all washed at the same time, a filter can be placed into service immediately after washing, probably without very much damage to the effluent of the plant as a whole.

In a smaller plant with a smaller number of units, in which it is the practice to wash the entire plant at one time, serious harm will be done to the effluent of the plant if all of the filters are put into operation at one time at full rate, as all of the water at that time, while not necessarily of a low quality, is certainly not what it should be.

In most plants I believe, and certainly it has been the practice with us, the first effluent from the filter after washing is wasted to the sewer, and this is what we know as the re-wash.

The point I wish to bring out at this time is that if the re-wash is properly used, while it wastes some water, it enables us to maintain at all times a high standard of effluent, but if used improperly more harm is done than good.

The purpose of the re-wash is really to age the sand bed by the accumulation of a new deck of floc uniformly over the entire area of our sand bed and in the upper layers, so that while the filter is in operation the water will pass uniformly at the same rate through the entire bed.

The re-wash connection on most filters is so large

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that if opened wide the water will pass through the bed at many times the normal rate of filtration. If the plant is operated entirely by hydraulic valves it is a rather difficult matter for the operator to control the amount of opening of the re-wash valve; and, therefore, particularly because a valve when it is part-way open will pass nearly as much water as it will when it is wide open, it is almost impossible for the operator to avoid passing through the re-wash as much water as it will carry.

The result of this is that, instead of the filter bed reaching a uniform condition in a few minutes, there are holes formed in the sand bed through which the water passes very rapidly, preventing the accumulation of any floc; and if the filter is then turned into service after a few minutes use of the re-wash, a low quality of effluent will be obtained throughout the entire run of the filter.

The next time the filter is washed this condition is corrected and if the re-wash valve is properly used at this time the same filter will produce a satisfactory effluent without apparently any reason for it.

We have found this to be true in our own plant and by very careful attention to the opening of the re-wash valve, making certain that the amount of water passing to the sewers is not in excess of the normal rate of the filter, we are now experiencing no difficulty from this feature and we are now contemplating, as soon as the work can be done, the installation of a choke in our re-wash connection that will make us independent of the opening of the re-wash valve and we can open this valve wide open with the assurance that no damage will be done to the sand bed.

We understand that this is being done in some of the more modern plants at the present time by using a very small re-wash connection.

My own opinion is that if a re-wash valve is not properly used, since there is no controller on such connections, that it would be far better to simply put the filter into regular operation at a low rate, slowly building it up to the rate we wish to carry, keeping it on your controller at all times. While this would pass some water not strictly up to what it should be it will only do so for a short time and the sand bed will at least be in condition for a satisfactory run until the next washing.

Growing Willows on Sewage Farms

The growing of willows on sewage farms is being advocated in England as a means of securing some returns from sewage disposal. The willows recommended are those known commercially in that country as "cricket bat willows," and it is stated that the average price obtained is $15 per tree, and that from 250 to 350 trees are grown on an acre, reaching maturity in twelve to fifteen years. It is reported that Glastonbury disposed of 63 willow trees to a manufacturer of cricket bats for about $2,500. These trees had been purchased in 1903 at a total cost of not more than $100, including planting and freight charges.

As there are about 90 different varieties of willows, it is essential that the trees should be carefully selected to be of the right variety, or they might find no market.

Study of Arch Dams

A nation-wide study of arch dams is about to be undertaken by the Engineering Foundation in cooperation with engineers of the west. The Engineering Foundation has appointed a committee of civil engineers consisting of Arthur P. Davis, director of the U. S. Reclamation Service; A. B. Fletcher, director of Public Works at Sacramento; M. M. O'Shaughnessy, city engineer of San Francisco; H. Hobart Porter and Silas H. Woodward, of New York; Prof. C. Derleth, Jr., of the University of California; F. A. Noltzli, of San Francisco; H. Hawgood, of Los Angeles, and D. C. Henny, of Portland, Ore.

This committee is collecting information from the owners of existing dams and plans to make measurements of existing dams and of those which are to be constructed in the near future, to learn as much as possible about their performance under different conditions of temperature and of depth of water in the reservoir. In addition, it is proposed to build one or more small dams for experimental purposes upon which tests can be made to try various theories and get information which it is not possible to obtain by measurements of existing dams.

Costs Are Increasing

All records concerning contracting and the construction business have indicated that during the past few months wages and prices have been advancing. The official organ of the Associated General Contractors expresses the belief that prices in general have been stabilized for the present on a new price level in the neighborhood of 70% higher than that which prevailed in 1913. "This means that prices will continue to go up until the present period of prosperity is fully established and will not go down again until the beginning of the next business depression. The next depression will probably be only a moderate one—such as we were familiar with before the war—and will be accompanied by only moderate decreases in prices.

"Instead of expecting that building costs will be materially lower eighteen months from now, we anticipate they will continue to increase during the greater part of that period and that they will be at that time perhaps at about the beginning of a decrease, but at a point higher than at present. We believe, further, that the decrease which may be expected to begin at about that time will not go to a point very much below the figures reached during the winter of 1921-22."

Delaware Highway Income

The State Highway Department of Delaware obtains almost its entire income from motor vehicle fees, the only additional income last year having been $49,000 appropriated by the State Legislature.

The state highway system has cost up to date $10,862,000 and includes 263 miles of road. Of this amount $7,450,000 has been paid from state and county funds. It is estimated that double this amount was spent in one year for automobiles owned by citizens.

Refuse Collection and Disposal Data*

Information furnished by several hundred municipal officials concerning the practices of their cities in collecting garbage, ashes and rubbish and in disposing of them.—(Continued from the December issue)

ELY, MINNESOTA

Ely, Minnesota, collects garbage by municipal employees and the city furnishes the garbage cans for each residence and business place. The population is about 5,000. About 750 garbage cans are in service, 200 being 6-gallon, 350 8-gallon, and 200 12-gallon. Garbage is collected from the business section every day and from residences every other day, Sundays excepted. The garbage is collected in a water-tight wagon of 2½ cubic yards capacity and the excess water is drained into the sewer at convenient places.

JOPLIN, MISSOURI

At Joplin, Missouri, garbage is collected by an association formed by the leading hotels of the city, which owns a hog ranch and collects the garbage from the entire city without cost to either city or property owners.

HASTINGS, NEBRASKA

Hastings, Nebraska, guarantees a local truckman $150 a month for collecting the garbage, the truckman soliciting the business and collecting $1.00 a month for each residence and $5.00 for markets and other commercial establishments. If the income exceeds $150 a month, the difference is divided equally between the city and the truckman.

MONTCLAIR, NEW JERSEY

In Montclair, New Jersey, population about 30,000, garbage is collected by municipal employees and sold to farmers for hog feeding, being delivered to them by the municipality. All the farmers are within the limits of a five-mile haul. For collecting the garbage, 2½-ton Packard trucks are used, with special 4-yard bodies. Three trucks are used during seven months of the year and four trucks during the other five months. Each truck has one chauffeur and three or four helpers. Collections are made twice per week for seven months and three times for five months, with extra collections from fish markets, boarding houses, etc. The number of loads varies from 33 to 50 per week, averaging 40, and averaging 3½ cubic yards per load. The farmers pay an average of $1.00 per load. Bids for the garbage were received the first of the year and the demand exceeded the supply by 40 per cent.

In Montclair rubbish and ashes are collected by municipal employees. The rubbish carts are of 7 cubic yards capacity, five carts being used. Only one man, the driver, is used with each cart, except that in the business district there is a helper. Collections are made once a week from all buildings and an average of fifty loads a week is collected. The rubbish collected is hauled to a dump near one end of the town, where all inflammable matter is burned in an open pit. Two men are employed at this dump. Ashes are collected twice a week for 7½ months of the year and once a week during the other 4½ months. Horse-drawn wagons are used, of 3½ cubic yards capacity, three being used in summer and about 10 in winter; three helpers being used in summer and an average of 20 in winter. The ashes are used for filling low land and surfacing some of the outlying streets.

The garbage trucks are all equipped with snow plows and are used for plowing the streets after a snowstorm. Following the severe storm early in 1922 a roadway fifteen feet or more wide was plowed on over 70 miles of streets within 24 hours after the storm had ceased.

PATERSON, NEW JERSEY

Paterson, New Jersey, collects all refuse with municipal teams and employees, the garbage and combustible refuse being taken to an incinerator. In the collection service the city uses electric tractors, gasoline trucks and horse-drawn wagons, the last-named being hired at $10 per day. During the year 1921, 57,381 cubic yards were hauled by electric tractors at a cost of 49.64 cents per cubic yard, plus 10.45 cents for overhead. The gasoline trucks collected 35,071 cubic yards at a cost of 67.33 cents per cubic yard, plus 11.40 cents overhead. The horse-drawn wagons collected 84,317 cubic yards, or nearly as much as the other two combined, at a cost of 64.04 cents per cubic yard. This gives a total of 176,769 cubic yards removed at a total cost, including overhead, of $130,828. Of this amount, 142,193 cubic yards was disposed of on dumps, the cost of maintaining which was 10.36 cents per cubic yard, which is included in the total just given.

The destructor plant during the year incinerated 34,576 cubic yards of material at a cost of $12,914 for wages and $3,031 for maintenance, an average of 46.11 cents per cubic yard; in addition to which the carting of the clinker from the plant cost $2,392 for removing the 2,087 cubic yards of clinker.

Of the cost for the electric tractors, which have

*Continued from page 284.

a capacity of 10 cubic yards each, 41.08 cents per cubic yard was for labor, 2.03 cents for current, 6.49 cents for maintenance. Of the cost of collecting by gasoline trucks, with capacities of 5 and 10 cubic yards, 51.45 cents was for labor, 5.90 cents for gasoline and 9.97 cents for maintenance. An inspection of the monthly records shows that horse collection was used to a larger extent during the winter months, the amount collected per month by horse-drawn wagons between April and October being only from one-quarter to one-half as much as during the winter. The amount collected per month by the electric tractors and gasoline trucks shows comparatively little variation between the monthly collections, indicating that the hired horse-drawn wagons are used largely for making up the deficiency in capacity of the city-owned equipment.

SUMMIT, NEW JERSEY

Summit, New Jersey, reports an unusual feature, found in very few other cities—that of the collection of refuse from the cellars of all householders who may wish it and who sign an application releasing the city from any liability of any character.

BUFFALO, NEW YORK

Buffalo, New York, collects all ashes, garbage and rubbish, insisting upon separation into these three classes, the ashes to contain also broken crockery, etc. Ashes and rubbish must be in receptacles weighing not over 100 pounds and the garbage in water-tight ones. For garbage, the tractor and trailer system is used, the trailers being horse-drawn, of 5-yards water-level capacity, side dump, with a fifth wheel. For ashes, wagons are used having a capacity of 5½ yards water level and of the bottom-dump type. The rubbish wagons have a capacity of 18 yards level full or 24 yards rounded up.

The tractors haul three trailers of garbage to a piggery 3½ miles beyond the city limits, with an average haul of nine miles through the city. The ash wagons drive directly to the various dumps, the average haul being 3 miles. The rubbish wagons go directly to the refuse utilization plant, the average haul being 6 miles. Here the contents are dumped into bins and from these put on conveyors, where they are sorted by women. The unsaleable residue is carried by the conveyors to the top of six Heenan-Froude furnaces, in which this material is burned. Steam is generated from the heat and is used for operating the machinery of the plant and for part of the power needed to operate the sewage pumping station which is adjacent to the plant.

The cost per yard during 1921 was as follows: For ashes, from a minimum of 52 cents per yard in December to a maximum of 91 cents in September, or an average of 69½ cents for the year. For garbage, from a minimum of $1.63 in September to a maximum of $3.15 in January, an average of $2.15. For rubbish, from a minimum of 45 cents in July to a maximum of 75 cents in January, an average of 59 cents. The total cost for the year ending June 30, 1922, for the collection of all refuse was $764,881.

HORNELL, NEW YORK

At Hornell, New York, garbage is collected by a private concern which changes the cans and sterilizes them once a week, charging the householder 85 cents per month. The garbage is fed to hogs.

ELLWOOD CITY, PENNSYLVANIA

Ellwood City, Pennsylvania, is one of the comparatively few municipalities that require citizens to wrap the garbage in paper. The garbage is burned in an incinerator.

OGDEN, UTAH

Ogden, Utah, is another city where the contractor for collecting the garbage furnishes the cans. He cleans the cans by steam. Collections are made daily in the business district. No charge is made to private citizens and the garbage is used for feed at the packing plant.

SEATTLE, WASHINGTON

An advantage of municipal collection of garbage over any collection where each property holder must pay the collector directly is stated by A. H. Dimock, city engineer of Seattle, to be that "there is no incentive for anyone to dispose of garbage on his own property or on vacant property belonging to other people in order to avoid the payment of collection charges. This happened very frequently before the city undertook to collect the garbage itself, but under the present plan all old sources of offense have been cleaned up and no new ones appear. Because of the thorough collection of all wastes, Seattle has become practically a flyless city. This again reacts in promoting the public health, although of course the value of this cannot be stated in figures."

MAKING FILL

KENOSHA, WISCONSIN

In Kenosha, Wisconsin, all refuse is dumped in the lake back of a breakwater and is covered with dirt from excavations. This is used for making a fill which is to be developed as a lake shore park and has been found very satisfactory. It is calculated that the value of the land reclaimed in one year was $27,500, while the total cost in 1921, including depreciation and interest, was $40,608. The equipment used is four Lee trailers, four trucks and six horses. The cost per cubic yard averaged $1.65 and the cost per capita per year about $1.00.

OAKLAND, CALIFORNIA

The mixed rubbish of Oakland, California, is dumped on a tidal flat as fill for future extension of the industrial district. The city has built a trestle onto the flat to facilitate the dumping and employs men to regulate it. Last year the cost to the city of this dump was about $20,000. A serious objection to the dump is the large number of flies and rats that infest it.

WILLMAR, MINNESOTA

Willmar, Minnesota, has no regular collection of garbage, but provides a city dump where it is delivered to teamsters. The city employs a man to go to the dump one day a week and cover all of the week's accumulation of garbage, and it is

(Continued on page 29)

ASH AND RUBBISH DISPOSAL

City	Method of disposal	Cost per year.	Average haul, miles.	Satisfactory?—Remarks
Alabama:				
Fairfield	Dump outside city, burn*	Nothing	....	Very
Birmingham	Open dump	.....	2	No
Mobile	Fill swamp	.....	2½	So far
Talladega	On dump	Nothing	1	No
Arizona:				
Clifton	On dump, burned	$300	2	Yes
Miami	Home-made incinerator*	.....	1	Yes
Tucson	On dump*	Nominal	4	No
Arkansas:				
Helena	Dumped on levee, burned	.....	....	Yes. River removes dump
Pine Bluff	Dumped over bluff at river, burned	.....	....	.....
California:				
Alameda	Dumped at one end of town	.....	....	.....
Glendale	City dump, burned; paper baled	.....	....	.....
Long Beach	Sorted, sold or burned	.....	....	Revenue less than cost of sorting
Marysville	Burned*	$360	2	No
Oakland	Dumped as fill on tide flat*	$20,000	....	Cheapest method. Flies and rats at dump objectionable
Ontario	Filling waste land	.....	2	At present
Petaluma	Dumped at sewer farm*	.....	....	.....
Richmond	Burned with oil in out-of-the-way places	.....	....	.....
Sacramento	Dumped in cuts & covered	.....	2	Fairly
San Gabriel	Dumped in arroyo	.....	2	Yes
Santa Ana	Dumped on river bank	.....	6	Yes
So. Pasadena	Fill low ground	.....	1	Yes
Stockton	Dumped on leased land	.....	2½	Fairly satisfactory
Upland	Dumped in a wash	.....	....	Yes
Colorado:				
Denver	City dump	$5,000	2½	Yes
Fort Collins	Dumped	$300	2	Yes
Greeley	Dumped	$500	¾	.....
Salida	Dumped and covered	.....	....	.....
Connecticut:				
Bridgeport	Ashes dumped	.....	..	.....
Bristol	Ashes dumped	.....	....	.....
Hartford	On twelve fills	.....	1	Yes
Middletown	Dumped	None	1½	Yes
New Britain	Dumped	$1,500	....	.....
New Haven	Dumped	$8,000	2	Yes
New London	Dumped on city land	.....	Approx. 1	Fairly so
Norwalk	Make fill	.....	1	Yes
Manchester	On two town dumps	.....	....	So far
Willimantic	City dumps	.....	1	Yes
District of Columbia:				
Washington	Ashes dumped, rubbish salvaged	Insignificant	2½	Yes
Florida:				
Clearwater	Dumped far from town	.....	....	Quite
Fort Myers	Burned out of town	.....	....	.....
Jacksonville	2 incinerators and fill	.....	....	.....
St. Petersburg	Plled on dump	$2,000	2	No
Sanford	Incinerator	....	1½	Yes
Georgia:				
Albany	Building land	20	½	Yes
Griffin	Incinerator	.....	....	.....
La Grange	Public dump	.....	1	.....
Rome	Open dump*	2,500	1	No
Idaho:				
Caldwell	Dumped	.....	1	No
Pocatello	Dumped	360	3	Yes
Twin Falls	Make streets	None	1½	Yes
Illinois:				
Blue Island	Dumped in clay hole	12,000	2	At present
Champaign	Fill low land	.....	....	Fairly so
Chicago	Dumped	$1.17 per cu. yd.	3	For ashes, yes; for rubbish, no
Chicago Heights	Dumped in quarry	.....	....	Yes
E. Moline	Dumped at end of town	.....	....	Increasingly unsatisfactory
Evanston	City dump; some ashes on street	.....	....	.....
Galesburg	Incinerator	.....	1½	Very
Glencoe	Combustible burned on dump, other on roads	.....	....	Fairly so
Joliet	Ashes on city dump	.....	....	.....
Kewanee	Combustible burned, other on low lots	.....	....	.....
Lincoln	City dump	.....	3	Yes
Oak Park	Dump	500	6½	Yes
Quincy	Dumps	.....	....	No
Indiana				
Columbus	Public dump	None	1	Yes
Elwood	Dumped at edge of city	.....	....	Fairly so
Mishawaka	Dump	300	1	Yes
Peru	Filling low land	.....	2	.....
Portland	Dump	$360	2-4	Yes
Richmond	Fill	.....	1¾	Yes
Shelbyville	Dump	.....	¾	.....
South Bend	Gravel pits	.....	....	.....
Valparaiso	Hauled to dump	100	1	Yes
Wabash	Ashes in alleys	500	Short	Yes
Iowa:				
Cedar Rapids	Fill lowlands	None	....	Yes
Charles City	2 dumps	.....	....	.....
Creston	Ashes on streets; rubbish on city dump	.....	....	Quite so
Davenport	Sanitary fill*	3,500	.....	Quite so
Dubuque	Fill low land	.....	....	Fairly so
Keokuk	Private	.....	....	Yes
Marshall	Dump	.....	2	Yes
Mason City	City dump	.....	1¼	No
Muscatine	City dump	.....	....	.....
Ottumwa	Fill	.....	....	.....

For foot notes, see page 29

ASH AND RUBBISH DISPOSAL—(Continued)

City	Method of disposal.	Cost per year.	Average haul, miles.	Satisfactory?—Remarks
Kansas:				
El Dorado	Dumped	.....	....	Not entirely
Salina	Dumped	$125	1½	.....
Kentucky:				
Ashland	Incinerator* and dump	900†	....	No
Fort Thomas	Filling	150	1	.....
Paducah	City dumps	.....	¾	Yes
Louisiana:				
New Orleans	Dumped on swamp, burned*	36,000	7	Incinerators under construction
Maine:				
Augusta	City dump	None	¾	Yes, for present
Old Town	Dump	336	2,000 ft.	Yes
Massachusetts:				
Adams	Public dump	300	2	Yes
Beverly	Filling streets, parks, etc.	.....	....	Yes
Dracut	Dumps	.....	½	.....
Fall River	Filling	.....	....	Yes
Fitchburg	Filling	.....	....	Yes
Haverhill	Dumps	.....	1	Yes
Holyoke	City dump—fill in ground	App. $7,000	1½	Yes
Ludlow	Town dump	15	1	Yes
Lynn	Nearest dump or fill	.....	....	.....
Malden	Fill	.....	1¼	Yes
Medford	Dumps, paper sold	.....	1	.....
Middleboro	Public dump; some ashes for sidewalks	.....	....	.....
New Bedford	Fill & dump	.....	1	Yes
Newburyport	Fill river front	300	1¾	Yes
Newton	Fill—papers burned	.....	1½	Need incinerator
North Andover	Fill	.....	....	Yes
Orange	Rubbish dumped, burned	.....	....	Very
Peabody	Dumps	.....	....	Yes
Rockland	Fill	.....	....	.....
Waltham	Fill for parks	.....	1½	Yes
Watertown	Private and public dumps	.....	½	Yes
Winchester	Filling	1,000	....	Yes
Michigan				
Alma	Fill	None	¾	Fairly so
Ann Arbor	Dump	.....	1½	Yes
Detroit	Rubbish, dump; ashes, streets	2,000,000	4½	Yes
Flint	Rubbish, dump; ashes, streets	5,400	½	Yes
Highland Park	Dump	.....	4	Yes
Holland	Fill swamps	300	1	Yes
Ishpeming	Fill	.....	....	Yes
Jackson	Fill	100	1½	Yes
Lansing	Dump	.....	1	.....
Ludington	Dump	None	½	Yes
Monroe	Dump in swamp	800	1	Yes
Muskegon	Dump	None	15	No
Niles	Fill ravines	.....	1	.....
Owosso	City dump	.....	....	Yes
Pontiac	Dump	1,100	1½	Yes
Port Huron	Public dump	.....	....	Very
Sault Ste. Marie	City dump	.....	....	No
Sturgis	City dump	20	½	Yes
Minnesota:				
Austin	Fill	.....	1½	Yes
Brainerd	City dump*	.....	....	.....
Ely	Dump on low lots	.....	2½	.....
Fairmont	Dumped in gully, burned	.....	1	.....
Rochester	Dump	1,200	3	No
Mississippi:				
Hattiesburg	Incinerator or dump	.....	....	Not entirely
Natchez	Dumped in river and bayous	.....	....	.....
Missouri:				
Columbia	City dump	.....	2	No
Jefferson	City dump	.....	....	.....
Joplin	Public dump	.....	....	.....
Kansas City	Fill lowland	None	5	No
Sedalia	Dumps	.....	1	Yes
Springfield	Dump	.....	....	.....
Montana:				
Havre	City dump	.....	1	.....
Kalispell	Fill	700	2	Yes
Fremont	City dump	.....	....	Yes
Nebraska:				
Hastings	City farm	600	2	No
Lincoln	City land	750	....	.....
Omaha	Public dumps	.....	....	.....
Nevada:				
Winnemucca	City dump outside city	.....	....	.....
New Hampshire:				
Dover	Rubbish, incinerator; ashes, dump	.....	....	Fairly so
Franklin	Grading	.....	1½	.....
Keene	Incinerator	2,000	....	Yes
Laconia	Ashes, grading; rubbish, dump	.....	....	.....
Nashua	Dumps	1,000	1	Yes
New Jersey:				
Asbury Park	Ashes for streets, rubbish sorted	None	3	Yes
Atlantic City	Filling city or rented land	.....	1¾	Yes
Bergenfield	Public dump, covered with earth	.....	....	.....
Freehold	Borough dump	.....	1	.....
Hackensack	Filling	.....	1	Yes
Irvington	Sanitary fill,* 30 ft. deep	.....	....	Yes
Millville	Fill	.....	....	No
Montclair	Rubbish dumped, burned. Ashes, fill	.....	....	Yes
Newark	Fill	12,000	2½	Yes
New Brunswick	Fill; combustible in incinerator	6,718	1	.....
Paterson	Garbage and refuse incinerated; ashes, fill	Dump, $14,735 Incinerator, 18,336	....	.....

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ASH AND RUBBISH DISPOSAL—(Continued)

City	Method of disposal	Cost per year	Average haul, miles	Satisfactory?—Remarks
New Jersey (Continued)				
Phillipsburg	Fill	.....	....	.....
Roselle Park	Dump and streets	$2,000	....	Yes
Spring Lake	Borough dump	None	1	Not entirely
Summit	Rubbish, dumped, burned; ashes, streets or private land	.....	....	Reasonably so
Westfield	Fill swamps	.....	....	No
New York:				
Albany	Ashes, public dumps	.....	....	.....
Amsterdam	In old canal	2,000	1	Yes
Auburn	Dumps	.....	1	Yes
Binghampton	Burned	.....	1½	Yes
Buffalo	Ashes, dumped; rubbish, sorted, incinerator	Profit	Ashes, 3; refuse, 6	Yes
Cortland	Dump	1,000	1	Yes
Glens Falls	Private lands or public dump	.....	....	Fairly
Hempstead	Ashes, roads	.....	2½	Yes
Hornell	City dump	.....	....	.....
Hudson	Ashes or dumps	.....	....	Yes
Kingston	Filling swamp	30,000	1½ to 2	Yes
Mineola	Public dump	.....	....	Neighbors complain
New York (Manhattan, Brooklyn Bronx Boroughs)	Filling city and private lands	About 3,000,000	2 to 10 by land and water	Creates valuable land
Niagara Falls	Into Niagara Rapids	.....	....	Yes
Oneida	City dump	.....	1	Yes
Ossining	Fill	.....	1	No
Poughkeepsie	Ashes, fill	.....	....	Yes
Syracuse	City dump	.....	....	.....
Tarrytown	Fill*	2,100	1	Yes
Utica	Fill	.....	1	For the present
Watervliet	Dump	.....	1	No
North Carolina				
Durham	Ashes, fill; rubbish, incinerators	.....	¾	Yes
Elizabeth City	Fill	4,271	½	No
Fayetteville	Fill and incinerator	.....	1	Yes
Goldsboro	Dump and incinerator	900	....	.....
Greensboro	Incinerator,* ashes, fill	.....	1½	Yes
Henderson	Dump	.....	2	No
Wilmington	Ashes, roads; rubbish, incinerator	.....	¾	Yes
North Dakota:				
Bismark	City dump	900	....	No
Fargo	Dump	.....	....	No
Jamestown	Potters field	300	1½	Yes
Mandan	Refuse, dump.	.....	1	Yes
Valley City	Refuse, city dump, sorted, burned	600	....	Yes
Washburn	Ashes, fill; rubbish, river bank	.....	....	.....
Ohio:				
Ashland	Dump	None	1½	Yes
Ashtabula	City dump	300	2	Partly
Bellefontaine	Dump	25	2	Yes
Bucyrus	Dump	None	½	Yes
Chillicothe	Dump	None	1	No
Circleville	Private dump	None	½	Yes
Columbus	Dumps in city	.....	....	Yes
Dayton	City dumps	.....	1½	Very
Delaware	City dump	None	....	.....
Freemont	Dump	.....	1	Yes
Galion	Dumps	.....	½	Yes
Portsmouth	Dumps*	None	2½	Yes
Urbana	City dump	.....	2	Yes
Wilmington	Fill	.....	....	Fairly so
Wooster	Private dumps	.....	....	No
Oklahoma:				
Ada	City dump	.....	3	Fairly so
Blackwell	Dump, burned	.....	3	No
Enid	Dump, burned	540	3	No
Oregon:				
Astoria	Dump, burned*	.....	....	No, fire fumes objectionable
Eugene	City dump	.....	....	Very
Klamath Falls	Private dump, burned*	.....	....	No
La Grande	Dump	.....	2¾	No
Pennsylvania.				
Altoona	.....	None	1½	Yes
Ashland	Dump	.....	1	.....
Berwick	Dump into river	.....	....	No
Bethlehem	City dumps	.....	....	Yes
Bloomsburg	Fill*	.....	2	Yes
Braddock	Combustible, incinerator; other, dump	.....	....	Yes
Carlisle	City dump	200	¾	No
Coatesville	Quarry holes	None	½	Yes
Dormont	Dump	.....	3	No
DuBois	Streets and swamp	.....	¾	Yes
Duquesne	City and private dumps	.....	....	.....
Easton	Combustible, incinerator; non-combustible, dump	880	1½	Yes
Erie	Dumps	$3,000	....	
Franklin	City and private dumps, burned	960	....	.....
Freeland	Dump	None	¾	Yes
Greenville	Dump	500	2	No
Hanover	Old quarries*	.....	....	Yes
Kittaning	Dump	.....	3	.....
Lebanon	Old quarries	.....	2	No
Lewistown	Dump	500	½	No
Meadville	Ashes, dump; rubbish, incinerator	.....	1½	Yes
New Brighton	Public dumps	.....	¾	No
Parkesburg	Public dump*	.....	....	Fairly so
Pittston	Ashes, streets; rubbish, dumped, burned	.....	¾	Yes

For foot notes, see page 29

ASH AND RUBBISH DISPOSAL—(Continued)

City	Method of disposal.	Cost per year.	Average haul, miles.	Satisfactory?—Remarks
Pennsylvania (Continued)				
Rankin	Dump	.....	¾	Yes
Steelton	Private dump	None	1	Yes
Summit Hill	Dump	.....	½	Yes
W. Pittston	On river bank	.....	1½	Yes
Williamsport	Old "log basins"*	.....	....	Yes
Winton	Dumped in mine cover	.....	Short	Yes
Rhode Island:				
Newport	Public dumps	2,606	....	Yes
South Carolina:				
Charleston	Dumped on salt marshes	.....	....	.....
Chester	Dumped in gullies, burned	.....	....	.....
Spartansburg	Dumped	.....	1	Yes
Tennessee:				
Memphis	On low lands	3,600	2½	Yes
Morristown	Dumped	.....	1	No
Texas:				
Amarillo	Incinerator	.....	....	Yes
Beaumont	Fill marsh	.....	1½	Yes
Dallas	Rubbish, incinerator*	.....	1½	Yes
Eagle Pass	Dump	.....	....	No
Eastland	Dump. Rubbish burned	$100	None	Yes
Galveston	Incinerator and burned at dump	7,128	....	Yes
McKinney	Incinerator	.....	....	.....
Navasota	Holes and dump	.....	1	No
Port Arthur	Fill	None	....	Yes
Utah:				
Brigham	City dump	25	1½	Yes
Ogden	Dumped in holes and covered	.....	....	.....
Vermont:				
Barre	Municipal dump; ashes on roads and lots	.....	....	Yes
Bennington	Dump	.....	3	No
Burlington	City dump	1,316	1	Not entirely
Virginia:				
Bristol	Dumps	.....	¾	Yes
Danville	On river bank*	.....	2	No
Fredericksburg	City dump	100	1¼	Yes
Lynchburg	Dumps	200	½	Yes
Newport News	Dump*	.....	1¾	For ashes
Petersburg	Dump	6,000	1½	Yes
Portsmouth	Combustible,* incinerator; other, city dumps	.....	....	Fairly so
Richmond	Dump	$150,689.12	1¼	Yes
Roanoke	Combustible,* incinerator; other, dump	.....	1	Yes
Washington:				
Chehalis	City dump,* burned	.....	....	.....
Seattle	Sanitary fill*	.....	....	Very
Spokane	Fill	$150	¾	Yes
Walla Walla	City dump, burned	600	2½	Yes
West Virginia				
Clarksburg	Dumped in ravine	.....	2	Yes
Huntington	Dump‡	800	2	Yes
Wisconsin:				
Appleton	City dump	.....	....	.....
Baraboo	Ashes, streets; rubbish, dump leased by city	.....	....	.....
Beaver Dam	Fill	None	2	.....
Fond du Lac	Ashes, streets and low land	.....	....	.....
Green Bay	Fill sloughs	None	1	Yes
Kenosha	In lake back of breakwater, covered with dirt, for park	.....	....	Very
Lake Geneva	Gravel pit in city	.....	....	No
Menasha	City dump	5,000	¾	Yes
Milwaukee	Incinerator*	.....	....	Perfectly except cost
Racine	Fills; combustible,* incinerator	None	¾	Yes
Sheboygan	Dump	.....	1	For the present
Wisconsin Rapids	Dump*	.....	2	For ashes
Wyoming:				
Cheyenne	City dump*	.....	2	Yes
Sheridan	City dump	.....	....	.....

*Includes garbage. †Cost of care of dump. For incinerator see garbage. ‡No ashes in city.

(*Continued from page 25*)

reported that no nuisance is occasioned. The dump is on the edge of the city.

IRVINGTON, NEW JERSEY

Irvington, New Jersey, collects ashes and garbage by municipal employees and dumps them on low land. The dump is covered with a liberal coating of earth and once a year is given a treatment of disinfectant. Land lately acquired is being filled to a depth of approximately 30 feet and is large enough, it is estimated, to receive the refuse for five years to come.

JAMESTOWN, NORTH DAKOTA

The satisfactoriness of dumping garbage and refuse at Jamestown, North Dakota, is attributed by City Engineer Hurning to the fact that the city pays $25 per month to see that the garbage is properly covered with lighter material, but especially to the fact that the local teamster who makes the collections is industrious and active and that nature has provided the city with a dry climate and good drainage. Undoubtedly the factor of dry climate is much more favorable to disposal of garbage in dumps than is the climate of eastern and southern cities where moisture in the air favors rapid decomposition.

WILLIAMSPORT, PENNSYLVANIA

Williamsport, Pennsylvania, has an unusual opportunity for disposing of its refuse. The city is built on a flat along the Susquehanna river, having approximately seven miles river front and being 7/8 of a mile wide. Early in its history it was a lumber city and for several miles along the river log basins were constructed, into which the logs were drawn after being rafted down the

(*Continued on page 38*)

GARBAGE DISPOSAL

City	Method of Disposal	Cost of Operation, Per Year	Make and Capacity of Plant	Cost of Plant	Annual Maintenance and Repairs	Distance from Center of City	Is It Satisfactory? Remarks
Alabama:							
Birmingham	Open dump	$90,000	None	.....	.....	.....	Will install garbage disposal plant in near future
Mobile	Hauled to swamp and burned	.....	.....	.....	.....	1 mi.	.....
Selma	Dumped on land	.....	.....	.....	.....	.....	No
Talladega	Dump	.....	.....	.....	.....	1 mi.	No
Arizona:							
Clifton	Burned on dump	$4,500*	.....	.....	.....	2 mi.	Yes
Miami	Burned	.....	Home-made grate of iron pipe	.....	.....	1 mi.	Yes
Tucson	Garbage dump	.....	.....	.....	.....	4 mi.	No
Arkansas:							
Helena	River side of levee	.....	.....	.....	.....	.....	Yes
California:							
Marysville	Burned	.....	.....	.....	.....	.....	No
Napa	Dump on land	.....	.....	.....	.....	.....	.....
Ontario	Bus. sec. for hogs; rest on land	5,000	.....	.....	.....	2 mi.	Yes (at present)
Petaluma	Sewer farm	.....	.....	.....	.....	2 mi.	.....
Richmond	Burned	.....	.....	.....	.....	.....	Unsatisfactory—Dump where burned unsightly
Sacramento	Hog feed	.....	None	.....	.....	2 mi.	Fairly
San Bernardino	Fed to hogs	.....	.....	.....	.....	.....	.....
Santa Ana	Fed to hogs	.....	.....	.....	.....	6 mi.	.....
So. Pasadena	Sold to hog farm	4,200	.....	.....	.....	6 mi.	Yes
Stockton	Dumped outside city	.....	.....	.....	.....	2½ mi.	.....
Colorado:							
Denver	Fed to hogs	.....	.....	.....	.....	7-10 mi.	Yes
Ft. Collins	Fed to stock	.....	.....	.....	.....	5 mi.	Yes
Greeley	Fed to hogs	.....	.....	.....	.....	.....	Fairly
Montrose	Fed to hogs	.....	.....	.....	.....	.....	.....
Salida	Dump	.....	.....	.....	.....	.....	.....
Connecticut:							
Bridgeport	Municipal reduction plant	71,790	.....	.....	.....	In city	
Bristol	Fed to pigs and burying	.....	.....	.....	.....	2 mi.	.....
Hartford	Fed to pigs and burying	24,293*	.....	.....	.....	1-5 mi.	Yes
Manchester	Dumped	.....	.....	.....	.....	.....	.....
Middletown	Dumps	No	.....	.....	.....	1 mi.	Yes
New Britain	Fed to swine	.....	.....	.....	.....	.....	.....
New Haven	Fed to pigs	40,000	.....	.....	.....	5 mi.	Yes
New London	Fed to swine	8,000	.....	.....	.....	3 mi.	Sale of swine covers cost
Norwalk	Dumped & covered	.....	None	.....	.....	.....	.....
Stratford	Burned, buried, fed to pigs	.....	.....	.....	.....	.....	No
Willimantic	Piggery	2,500	.....	.....	.....	2 mi.	Yes
District of Columbia:							
Washington	Reduction	175,000	Modified Chamberlain 350 ton	.....	$100,000	35 mi.	Yes
Florida:							
Clearwater	Dump and burned	$7,200	.....	.....	.....	.....	Yes
Fort Myers	Incinerator	.....	.....	.....	.....	.....	.....
Gainesville	Incinerator and fed to hogs	.....	.....	.....	.....	.....	.....
Jacksonville	2 Incinerators	.....	.....	.....	.....	.....	.....
Sanford	Incineration	400	Nye—20-ton	.....	New	1 mi.	Yes
St. Petersburg	Burned	3,000	1 10-ton Nye & 1 15-ton Bayless	Unknown	$1,000	1 mi.	Yes—Expect to install garbage disposal plant in near future
Georgia:							
Albany	Crematory	240	.....	10,000	100	1 mi.	Yes
Griffin	Fertilizer and incinerated	.....	.....	.....	.....	.....	Yes
La Grange	Incinerated	600	"Nye Odorless"—12-ton	5,000	50	½ mi.	Yes
Rome	Open dump	.....	.....	.....	.....	.....	No

*Including collection.

Idaho:							
Boise City	Fed to hogs	.....	.....	.....	.....	.....	.....
Caldwell	Dump	.....	.....	.....	.....	.....	No
Twin Falls	Dump grounds	None	None	.....	.....	1 mi.	No—Expect to install garbage disposal plant in near future
Pocatello	Dump	.....	.....	.....	.....	2 mi.	Yes
Illinois:							
Blue Island	Clay hole	.....	.....	.....	.....	2 mi.	Yes
Champaign	Burying and fed to hogs	.....	.....	.....	.....	.....	Fairly
Chester	Dumps or lots	.....	.....	.....	.....	.....	.....
Chicago	Reduction	454,000	No Std. make; cap. 500 ton	2,000,000	40,000	Center	No
Chicago Heights	Incineration	.....	McGuire 6-ton cap.	.....	.....	1 mi.	Yes
East Moline	Fed to hogs, dumps	.....	.....	.....	.....	Outside	No
Evanston	Incineration	.....	.....	.....	.....	2½ mi.	Yes
Galesburg	Incineration	14,000	E. M. Jones, St. Louis	.....	.....	1¼ mi.	.....
Glencoe	Fed to hogs and buried	.....	.....	.....	.....	1½ mi.	Yes
Joliet	Burned	.....	.....	.....	.....	.....	.....
Kewanee	Dumped in Sylvan Glen	1,576	.....	.....	.....	2 mi.	Yes
Lincoln	City dump & burned	$600	None	.....	.....	3 mi.	No
Marion	Dumped on city land	.....	.....	.....	.....	Out of City	Yes
Murphysboro	Buried	3,000	.....	.....	.....	.....	Yes
Oak Park	Incineration	12,000	Lewis & Kitchen—50-ton	11,858	3,500	Center	No
Quincy	Fed to hogs, dumped	.....	.....	.....	.....	.....	
Indiana:							
Columbus	Public dump	5,000	.....	.....	.....	1 mi.	Yes
Elwood	Dump, fill	.....	.....	.....	.....	Edge of City	Fairly
Lafayette	Burned	7,762	.....	.....	.....	.....	.....
Lebanon	Hauled to country	.....	.....	.....	.....	.....	.....
Mishawaka	Buried	.....	.....	.....	.....	.....	.....
Peru	Given to farmers	.....	.....	.....	.....	.....	.....
Portland	Fed to stock	$500	None	.....	.....	2 mi.	Yes
Richmond	Hog feed and incineration	Plant new	Smith 18—30-ton	.....	.....	¼ mi.	Yes
Shelbyville	Fed to hogs	1,500	.....	.....	.....	.....	.....
South Bend	Fed to hogs	.....	.....	.....	.....	.....	.....
Terre Haute	Fed to hogs	.15 per capita	.....	.....	.....	.....	.....
Valparaiso	Dump	$2,500	.....	.....	500	1½ mi.	.....
Wabash	Fed to hogs	.....	.....	.....	.....	.....	.....
West Lafayette	Fed to hogs	.....	.....	.....	.....	2 mi.	Quite
Iowa:							
Ames	Fed to hogs	.....	.....	.....	.....	.....	Fairly
Cedar Rapids	Dumped in open	1,900	.....	.....	.....	2 mi.	No—Expect to install garbage plant in near future
Charles City	Fed to hogs	.....	.....	.....	.....	.....	.....
Cresco	Buried	.....	.....	.....	.....	.....	Yes
Creston	Fed to hogs	.....	.....	.....	.....	.....	Quite
Davenport	Fill low land	.....	.....	.....	.....	.....	.....
Dubuque	Reduction plant	.....	.....	.....	.....	.....	No
Eagle Grove	Dump ground	.....	.....	.....	.....	.....	.....
Keokuk	Buried	.....	.....	.....	.....	1 mi.	.....
Marshall	Dump	.....	.....	.....	.....	2 mi.	No
Mason City	Incineration	$2,833	Jones	$14,000	$10	1¼ mi.	Yes
Muscatine	Fed to hogs	.....	.....	.....	.....	.....	.....
Ottumwa	Burned	1,600	Jones 24-ton per day	$18,000	$100	1 mi.	Yes
Kansas:							
El Dorado	Fed to hogs	.....	.....	.....	.....	.....	.....
Independence City	Fed to hogs	.....	.....	.....	.....	.....	Yes
Salina	Low dumps	.....	.....	.....	.....	.....	.....
Kentucky:							
Ashland	Incineration	100	.....	.....	.....	.....	.....
Ft. Thomas	Fed to hogs	3,000(G&R)	.....	.....	.....	1 mi.	No
Madisonville	Taken to farms	.....	.....	.....	.....	.....	.....
Paducah	Fed to hogs	.....	.....	.....	.....	.....	No
Winchester	Burned	.....	.....	.....	.....	.....	.....
Louisiana:							
New Orleans	Dumped in swamp and burned	.....	.....	.....	.....	.....	.....

GARBAGE DISPOSAL—(Continued)

City	Method of Disposal	Cost of Operation, Per Year	Make and Capacity of Plant	Cost of Plant	Annual Maintenance and Repairs	Distance from Center of City	Is It Satisfactory Remarks
Maine:							
Augusta	Fed to pigs	.....	.....	.....	.....	.....	Yes
Oldtown	City dump	$350	.....	.....	.....	½ mi.	.....
Massachusetts:							
Adams	Town farm	.....	.....	.....	.....	1 mi.	Yes
Beverly	Fed to pigs	.....	.....	.....	.....	.....	Yes
Brockton	Fed to pigs	.....	.....	.....	.....	.....	Yes
Fall River	Fed to pigs	.....	.....	.....	.....	.....	Yes
Fitchburg	Fed to pigs and plowed in land	.....	.....	.....	.....	.....	Yes
Haverhill	Out of city	.....	.....	.....	.....	.....	.....
Holyoke	Collectors use or sell	.....	.....	.....	.....	.....	.....
Lynn	Sold by annual contract	.....	.....	.....	.....	.....	.....
Medford	Sold to farmers	.....	.....	.....	.....	8 mi.	.....
Middleboro	Feeding hogs	.....	.....	.....	.....	.....	.....
New Bedford	Reduction plant	$90,000	Cobwell 50-ton per day	.....	.....	3 mi.	Yes
Newton	Sold by contractor	31,300	.....	.....	.....	.....	Fairly
No. Adams	Fed to hogs	.....	.....	.....	.....	.....	.....
Peabody	Fed to swine	.....	.....	.....	.....	.....	.....
Rockland	Dump	.....	.....	.....	.....	1 mi.	.....
Watertown	Contractor disposes of it	.....	.....	.....	.....	.....	Yes
Winchester	Sold to contractor	7,500	.....	.....	.....	⅓ mi.	Yes
Worcester	Fed to swine	.....	.....	.....	.....	.....	Yes
Michigan:							
Alma	Fed to hogs	.....	.....	.....	.....	1.5 mi.	Yes
Ann Arbor	Fed to hogs	.....	.....	.....	.....	.....	.....
Detroit	Reduction plant	.....	.....	.....	.....	Out of city	.....
Flint	Fed to hogs	Gr. profit, $14,290	.....	.....	.....	12 mi.	Yes
Highland Park	Reduction	.....	.....	.....	.....	.....	.....
Ishpeming	Burned	.....	Hunter McGuire Incinerator	.....	.....	½ mi.	Yes
Jackson	Buried	.....	.....	.....	.....	2 mi.	No
Lansing	Fed to hogs	.....	.....	.....	.....	4 mi.	Yes
Ludington	Burned	$1,200	.....	.....	.....	1½ mi.	Yes
Monroe	Burned in swamp	.....	.....	.....	.....	.....	.....
Muskegon	Dump	19,000	.....	.....	.....	.....	.....
Niles	Fed to hogs	.....	.....	.....	.....	.....	.....
Pontiac	Hog farm	Self-support	.....	.....	.....	5 mi.	Yes
Port Huron	Fed to pigs and chickens	.....	.....	.....	.....	.....	Very
Sault Ste. Marie	City dump, hog feed	.....	.....	.....	.....	.....	No
Sturgis	Fed to hogs	.....	.....	.....	.....	.....	.....
Minnesota:							
Austin	Buried	17.20	.....	.....	.....	2 mi.	Yes
Brainerd	Municipal dump and fed to hogs	.....	.....	.....	.....	.....	.....
Ely	City dump	.....	.....	.....	.....	2 mi.	Yes
Fairmont	Fed to hogs, burned	.....	.....	.....	.....	.....	.....
Minneapolis	Incineration	.....	.....	.....	.....	.....	.....
Pipestone	Fed to hogs	.....	.....	.....	.....	.....	.....
Rochester	Hog farm	6,000	.....	.....	.....	3 mi.	Yes
St. Paul	Fed to hogs	Ap. 60,000	.....	.....	.....	.....	.....
Willmar	City dump	.....	.....	.....	.....	.....	.....
Mississippi:							
Natchez	Dumped in river	.....	.....	.....	.....	.....	.....
Missouri:							
Columbia	City dump	.....	.....	.....	.....	About 1½ mi.	No
Joplin	Fed to hogs	.....	.....	.....	.....	.....	.....
Kansas City	Hog feeding	.....	.....	.....	.....	.....	Expect to install garbage plant in near future
Sedalia	Incinerated	.....	24-ton Nye Odorless	$16,000	None	¾ mi.	Yes
Springfield	Hog feeding	None	None	.....	.....	.....	No
Montana:							
Havre	Fed to hogs, city dump	.....	.....	.....	.....	1 mi.	Yes
Kalispell	Burned	1,500	.....	.....	.....	2 mi.	Yes

Nebraska:							
Fremont	Fed to hogs, city dump	.....	.....	.....	.....	.....	Very
Hastings	Buried	700	.....	.....	.....	1½ mi.	Yes
Lincoln	Fed to hogs, city dump	.....	.....	.....	.....	.....	.....
Omaha	Fed to hogs, city dump	.....	.....	.....	.....	.....	.....
Nevada:							
Winnemucca	City dump	.....	.....	.....	.....	Out City Limits	.....
New Hampshire:							
Franklin	Dumped	2,000	.....	.....	.....	2 mi.	No
Keene	Incinerated, hog feed	2,000	.....	.....	.....	.....	Yes
Nashua	Fed to pigs	.....	.....	.....	.....	.....	.....
New Jersey:							
Asbury Park	Fed to hogs	.....	.....	.....	.....	2 mi.	No
Atlantic City	Incinerated	.....	Owned by contractors	.....	.....	15 mi.	Yes
Bergenfield	Public dump	.....	.....	.....	.....	.....	Yes
Freehold	Fed to hogs	.....	.....	.....	.....	3 mi.	Fairly
Garfield	Fill low land	.....	.....	.....	.....	.....	.....
Hackensack	Fill meadows	.....	.....	.....	.....	½ mi.	Yes
Irvington	Dumped on low land	.....	.....	.....	.....	.....	Very
Long Branch	Dumped, fed to swine	.....	.....	.....	.....	Outlying Dist.	.....
Millville	Fed to pigs and chickens	.....	.....	.....	.....	.....	Very poor
Montclair	Hog feeding	Rec'd $1 per load	.....	.....	.....	5 mi.	.....
Newark	Fed to hogs	Privately owned	.....	.....	.....	2.5 mi.	.....
New Brunswick	Fed to hogs; incinerated	.....	.....	.....	.....	.....	.....
Newton	Back of lots	.....	.....	.....	.....	.....	No
Orange	Taken care of by contractors	.....	.....	.....	.....	.....	.....
Paterson	Burned in incinerator	$15,305	Heenan destructor	.....	$3,031	1 mi.	.....
Phillipsburg	Plowed under ground	.....	.....	.....	.....	2 mi.	.....
Rahway	Dumped on lowland	.....	.....	.....	.....	.....	Contemplate erect. of incin
Roselle Park	Dump	3,000	.....	.....	.....	.....	No
Spring Lake	Fed to hogs	.....	.....	.....	.....	8 mi.	Not entirely
Summit	Fed to hogs	.....	.....	.....	.....	.....	Reasonably
Westfield	Sold to farmers	.....	.....	.....	.....	.....	No
New York:							
Albany	Fed to hogs	.....	.....	.....	.....	.....	.....
Amsterdam	Burned	8,000	Morse-Boulger Incinerator	15,000	3,000	2 mi.	Yes
Auburn	Buried outside city	.....	.....	.....	.....	.....	.....
Binghampton	Burned	$51,079	.....	.....	.....	.....	.....
Buffalo	Hog feeding	Profit made	.....	.....	.....	9 mi.	Yes
Carthage	Feeding swine; buried	.....	.....	.....	.....	.....	No
Glens Falls	Fed to swine; dumped	.....	.....	.....	.....	.....	No
Gloversville	Dumped	.....	.....	.....	.....	Outside city	.....
Hempstead	Buried	8,000	.....	.....	.....	2 mi	Yes
Herkimer	Bank of river	.....	.....	.....	.....	Near city limits	Yes
Hornell	Fed to hogs; buried	.....	.....	.....	.....	.....	.....
Hudson	Fed to hogs; buried	2,200	.....	.....	.....	.....	Very
Kingston	Plowed in ground out of city	9,000	.....	.....	.....	.....	.....
Little Falls	Fed to pigs	.....	.....	.....	.....	.....	.....
Mineola	Dump	.....	.....	.....	.....	Outside village	No; nuisance
N. Y.: Manhattan, Bklyn & Bronx Boros.	Dumped at sea	23c per ton	.....	.....	.....	15-20 mi.	No; expensive and pollutes shores
Niagara Falls	Dumped into rapids	.....	.....	.....	.....	.....	Yes
Oneida	Dump	.....	.....	.....	.....	1 mi.	Yes
Ossining	On farmland	.....	.....	.....	.....	3 mi.	No
Oswego	Fed to hogs; dump	.....	.....	.....	.....	Dump in country	No
Poughkeepsie	Fed to hogs; buried	.....	.....	.....	.....	.....	.....
Schenectady	Reduction plant	17,500	Garbage Reduction Plant	160,000	.....	.....	.....
Syracuse	Reduction plant	.....	Cobwell Reduction Plant	.....	.....	.....	Very (sanitary); no (expen.)
Tarrytown	Fill	.....	.....	.....	.....	3,000 ft.	Yes
Utica	Pig farm	.....	.....	.....	.....	3 mi.	Not entirely
Watertown	Fed to pigs	.....	.....	.....	.....	.....	.....
Watervliet	Dump	.....	.....	.....	.....	.....	No
North Carolina:							
Durham	Buried	.....	2 Nye Odorless Incinerators	16,000	100	¼ mi.	Yes
Elizabeth City	Hauled to country	.....	.....	.....	.....	2 mi.	No
Fayetteville	Incinerated	1,200	10-ton Nye Odorless Incin.	4,000	25	1,500 ft.	Yes
Goldsboro	Dump and incinerated	.....	.....	.....	.....	.....	Crude system

GARBAGE DISPOSAL—(Continued)

City	Method of Disposal	Cost of Operation, Per Year	Make and Capacity of Plant	Cost of Plant	Annual Maintenance and Repairs	Distance from Center of City	Is It Satisfactory Remarks
Greensboro	Incinerated	$5,000	Nye Odorless Incinerator	$20,000	$150	1½ mi.	Yes
Henderson	Dumped	3,000	.....	.....	.....	.....	Opera. cost inc. ash & rub.
Wilmington	Sold to farmers	4,100	.....	.....	.....	.....	.....
North Dakota:							
Bismarck	City dump	900	.....	.....	.....	.....	Unsatis.; poss. build ere. lat.
Fargo	Dump ground	.....	.....	.....	.....	Out of city	Very (incin. contemplated)
Jamestown	Potter's field	Ap. 300	.....	.....	.....	1½ mi.	Yes
Mandan	Dumped on land	.....	.....	.....	.....	1 mi	Entirely
Valley City	City dump; burned	$600	.....	.....	.....	.....	Yes
Washburn	Over bank into river	.....	.....	.....	.....	.....	No change contemplated
Ohio:							
Akron	Fed to hogs	Not known	.....	.....	.....	9 mi.	No
Ashland	Sold for feed	2,400	.....	.....	.....	.....	Yes
Ashtabula	Buried outside city	1,500; (G&R)	.....	.....	.....	.....	.....
Bellefontaine	Dump	.....	.....	.....	.....	½ mi.	Yes
Bucyrus	Fed to hogs	3,000	.....	.....	.....	2 mi.	No
Canton	Hog ranch	Nominal	.....	.....	.....	.....	Yes
Chillicothe	Dump	7,000	.....	.....	.....	2 mi.	No
Cincinnati	Reduction	.....	.....	.....	.....	.....	.....
Columbus	Reduction	Profit	.....	.....	.....	.....	Yes
Dayton	Reduced	40,000	Bastard	60,000	.....	8 mi.	Very
Delawsre	Fed to pigs	.....	.....	.....	.....	.....	.....
Elyria	Fed to pigs and reduction	.....	.....	.....	.....	.....	Very
Fremont	Plowed under	.....	.....	.....	.....	.....	Yes
Lancaster	Dumped and fed to hogs	.....	.....	.....	.....	Out of city	.....
Lima	Sold to farmers	.....	.....	.....	.....	.....	No
Niles	Public dump	.....	.....	.....	.....	.....	.....
Portsmouth	Dumps	8,100	.....	.....	.....	.....	.....
Urbana	Fed to hogs	.....	.....	.....	.....	1 mi	Yes
Van Wert	Fed to hogs	.....	.....	.....	.....	.....	.....
Wilmington	Fed to hogs	None	.....	.....	.....	.....	.....
Wooster	Fed to hogs	.....	.....	.....	.....	Outside city	Yes
Youngstown	Creamatory and hog farm	.....	.....	.....	.....	8 mi.	.....
Zanesville	Burned; fed to pigs	.....	.....	.....	.....	.....	.....
Oklahoma:							
Ada	Fed to hogs	.....	.....	.....	.....	1 mi	.....
Blackwell	Burned at dump	.....	.....	.....	.....	2 mi.	No
Enid	Fed to hogs; burned	.....	.....	.....	.....	2 mi.	No
Okla. City	Fed to hogs; dump	.....	.....	.....	.....	.....	.....
Oregon:							
Astoria	Burned; fed to hogs	.....	.....	.....	.....	.....	No; odor from burning
Eugene	Fed to hogs; dump	.....	.....	.....	.....	.....	.....
Klamath Falls	Dump; burned	.....	.....	.....	.....	.....	No
La Grande	Pig feed	None	.....	.....	.....	2 mi.	No
Pendleton	Dump	.....	.....	.....	.....	1.3 mi.	.....
Pennsylvania:							
Altoona	Incinerated	4,000	Decarie 50-ton	$70,000	750	3 mi.	Yes
Beaver Falls	Incinerated	.....	Lewis & Kitchen	.....	.....	½ mi.	.....
Berwick	Dumped on river bank	.....	.....	.....	.....	.....	No
Bethlehem	Hog feeding; dumps	.....	.....	.....	.....	.....	Yes, tho dump mainten. exp
Braddock	Dump	.....	.....	.....	.....	.....	.....
Carlisle	Fed to pigs	2,000	.....	.....	.....	2 mi.	Yes
Clairton	Incinerated	.....	.....	.....	.....	.....	Very
Coatesville	Fed to hogs; buried	.....	.....	.....	.....	.....	.....
Dormont	Fed to hogs	.....	.....	.....	.....	.....	No
Domont	Incinerated	.....	Decarie incinerator	.....	.....	.....	.....
Easton	Incinerated	12,424	35-ton Morse-Boulger	13,390	6,780	1½ mi.	Yes
Elizabethtown	Fed to hogs; dump	.....	.....	.....	.....	.....	Some complaints of dump
Ellwood	Incinerated	.....	.....	.....	.....	½ mi.	.....

Erie	Fed to hogs	.....	.....	.....	.....	4½ mi.	.....
Franklin	Dump	960	.....	.....	.....	.....	.....
Freeland	Burned	800	.....	.....	.....	1 mi.	Yes
Greenville	Fed to pigs; dumps	.....	.....	.....	.....	2 mi.	.....
Hanover	Old stone quarries	.....	.....	.....	.....	.....	.....
Hazeltown	Ash dump, cow and hog feed	.....	.....	.....	.....	.....	.....
Kittaning	Fed to pigs	.....	.....	.....	.....	.....	.....
Lebanon	Dump	.....	.....	.....	.....	1 mi.	.....
Lewistown	Dump	.....	.....	.....	.....	.....	No
Lock Haven	Buried in pits	.....	.....	.....	.....	.....	No
Meadville	Hog feed and incineration	.....	Dixon 25-ton (1903)	8,258	300-400	Incin. 1½, plg. 3	Yes
New Brighton	Taken to country	.....	.....	.....	.....	.....	.....
No. Braddock	Incinerated	Ap. 3,000	Decarie	28,000	.....	1 mi.	Yes
Parkesburg	Public dump	.....	.....	.....	.....	.....	Fairly
Pittston	Burned	12,000	.....	.....	.....	½ mi.	Yes
Rankin	Incinerated	6,049	Decarie 10-ton	10,500	.....	½ mi.	Yes
Steelton	Private property	.....	None	.....	.....	.....	.....
Summit Hill	.....	2,000	.....	.....	.....	½ mi.	Yes
Tyrone	Feed hogs; burned	.....	.....	.....	.....	.....	.....
W. Pittston	Dump	None	.....	.....	.....	1 mi.	Yes
Wilkensburg	Reduction	.....	.....	.....	.....	20 mi.	.....
Winton	Fill in low land	$250	None	.....	.....	.....	.....
Rhode Island:							
Newport	Dump	.....	.....	.....	.....	Lower part city	.....
Providence	Fed to swine	.....	.....	.....	.....	Island out of city	.....
South Carolina:							
Charleston	Burned; salt marshes	2,147 (3 mo.)	Griscom-Russell Destructor	.....	7,585	.....	.....
Spartanburg	Burned	.....	5-ton	.....	.....	½ mi.	Yes
South Dakota:							
Winner	Fed to hogs	.....	....	.....	.....	.....	.....
Tennessee:							
Cleveland	Fed to hogs	.....	.....	.....	.....	.....	Yes
Memphis	Incineration	59,732.72	50-ton Sparks & Dixon	2,000	3,000	1 mi.	.....
Morristown	Burned	Ap. 10,000	.....	.....	.....	.....	.....
Texas:							
Amarillo	Fed to hogs; incineration	.....	.....	.....	.....	.....	.....
Beaumont	Incineration	Ap. 35,000	Nye Odorless	25,000	250	2 mi.	Yes
Dallas	Incinerated	Ap. 1.50 per ton	Stokes 3 40-ton, 1 80-ton	163,000	.....	1 mi.	Yes
Denton	Dump	.....	.....	.....	.....	Out of city	.....
Eagle Pass	Burned	Ap. 2,600 (G&R)	.....	.....	.....	2 mi.	No
Eastland	Burned	1,500	Stokes incinerator, 12-ton	15,000	100	6 mi.	Yes
Galveston	Incinerated and dump	.....	.....	.....	.....	.....	No; need more incinerators
McKinney	Fed to hogs	.....	.....	.....	.....	.....	.....
Mineral Wells	Dump	.....	.....	.....	.....	.....	No; disease germs
Navasota	City dump	.....	.....	.....	.....	.....	No
Port Arthur	Incinerated	.....	Superior 10-ton	10,000	500	1 mi.	Yes; propose to install 30-ton plant
Utah:							
Logan City	Fed to hogs	.....	.....	.....	.....	.....	.....
Ogden City	Feed at packing plant	.....	.....	.....	.....	.....	Very
Vermont:							
Barre	Fed to hogs & chicks., burn., bur'd	.....	.....	.....	.....	.....	.....
Bennington	Dump	.....	.....	.....	.....	3 mi.	No
Burlington	Fed to swine	None	.....	.....	.....	.....	Yes
Springfield	Fed to swine	.....	.....	.....	.....	.....	.....
Virginia:							
Danville	Dump on river bank	.....	.....	.....	.....	2 mi.	No
Fredericksburg	Fed to hogs; buried	.....	.....	.....	.....	.....	.....
Lynchburg	Incinerated	1,776	Decarie—25-ton	$25,000	$300	1 mi.	Yes
Newport News	Dump; fill	14,500	.....	.....	.....	1 mi.	No
Norfolk	Feeding hogs; incinerated	.....					
Petersburg	Incinerated	.....	Decarie	25,000	500	1,000 ft.	Yes—need another inciner.
Portsmouth	Incinerated	.....	.....	.....	.....	.....	.....
Richmond	Cremated	14,831	2 50-ton plants	58,000	50	¼ mi	Yes
Roanoke	Incinerated	.....	Decarie	50,000	100	1½ mi.	.....

GARBAGE DISPOSAL—(Continued)

City	Method of Disposal	Cost of Operation Per Year.	Make and Capacity of Plant	Cost of Plant	Annual Maintenance and Repairs	Distance from Center of City	Is It Satisfactory?; Remarks
Washington:							
Aberdeen	Burned on dump	.....	.....	.....	.....	Outside city	.....
Chehalis	Dump	.....	.....	.....	.....	.....	Fairly
Seattle	Fill lowlands	30c per ton	.....	.....	.....	.....	.....
Spokane	Incinerated	$4,000	Decarie 50-ton	$90,000	$1,000	1 mi.	Yes
Walla Walla	Fed to hogs	.....	.....	.....	.....	.....	Yes
West Virginia:							
Bluefield	Fed to hogs	.....	.....	.....	.....	.....	.....
Clarksburg	Burned	16,000	30-ton	13,000	1,000	2 mi.	Yes
Huntington	Incineration	20,000	Nye Odorless—70-ton	.....	.....	.....	Yes
Parkersburg	Fed to hogs	.....	.....	.....	.....	.....	Fairly
Wisconsin:							
Appleton	Fed to hogs	.....	.....	.....	.....	.....	.....
Baraboo	Dump	.....	.....	.....	.....	.....	.....
Fond du Lac	Fill park	.....	.....	.....	.....	.....	No—bad odor
Green Bay	Fed to hogs	.....	.....	.....	.....	2 mi.	Yes
Janesville	Fed to hogs	.....	.....	.....	.....	.....	.....
Kenosha	Dumped in lake	.....	.....	.....	.....	.....	Very
Lake Geneva	Gravel pit	.....	.....	.....	.....	City limit	No; fire danger and odor
Menasha	Fed to hogs	.....	.....	.....	.....	½ mi.	No
Milwaukee	Incineration	.....	Heenan & Froude	.....	.....	.....	Yes; need another
Racine	Incineration	40,000	10-ton per 18-hr. day	30,000	3,000	Center city	.....
Sheboygan	Burned	Ap. 11,000	Hunter McGuire—12-ton	10,000	.....	Near center	Yes
Shorewood	Plow under farm land	.....	.....	.....	.....	.....	.....
Wisconsin Rapids	Dump	5,700	.....	.....	.....	1 mi.	No
Wyoming:							
Cheyenne	City dump	.....	.....	.....	.....	2 mi.	No
Sheridan	City dump; feed pigs & chickens	.....	.....	.....	.....	.....	.....

STREET CLEANING—SUPPLEMENTARY DATA

City	Miles of Street Cleaned: Daily	1 to 3 Times a Week	Less Than Once a Week	Equipment Owned by City	Equipment Preferred for Use on Each Kind of Pavement: Kind of Pavement	Equipment Preferred
Alabama						
Birmingham	7	8	150	60 hand brooms, 2 motor-driven flush mch., 11 h. d. sprinkling wagons, 8 dirt wagons	.....	.....
California						
Sacramento	10	130	..	50 hand brooms, 15 hand scrapers, 2 vacuum str. cleaners, 11 can carriers, 2 comb. flush & sprink. h. d. wagons, 10 dirt wagons & carts	Bit. conc., res. dist. Stone blk., mac., bus. dist.	Vacuum cleaner—Not practical in bus. dist. owing to traffic congestion. Hand sweeping
Colorado						
Boulder	..	..	..	8 hand brooms, 2 m. d. flush mch., 2 m. d. sprink. wagons, 2 dirt wagons, 1 snow plow	.....	.....
Connecticut						
Norwalk	2	..	..	36 hand brooms, 12 h. scrapers, 2 h. d. mch. brooms, 3 h. d. sprink. wagons, 1 squeegee, 2 dirt carts, 8 snow plows	.....	Broom on all
Florida						
St. Petersburg	3	0	70	25 hand brooms, 8 hand scrapers, 6 pickup sweepers, 2 can carriers, 4 dirt wagons, 6 dirt carts, 2 rub. trucks	.....	.....

STREET CLEANING—SUPPLEMENTARY DATA—(Continued)

City	Miles of Street Cleaned: Daily	1 to 3 Times a Week	Less Than Once a Week	Equipment Owned by City	Equipment Preferred for Use on Each Kind of Pavement: Kind of Pavement	Equipment Preferred
Idaho						
Twin Falls	4	2	8	12 hand brooms, 2 hand scrapers, 1 gutter sweep. mch., 1 can carrier, 1 h. d. flush mch., 1 motor-driven flush mach., 4 h. d. sprink. wagons, 2 dirt wagons	.....	Broom preferred
Illinois						
Lincoln	2	3	..	24 hand brooms, 1 h. d. mach. broom, 1 h. d. flush mach., 1 h. d. sprink. wagon, 3 dirt wagons, 2 dirt carts, 5 snow plows	.....	.....
Indiana						
Portland	2	5	7	24 hand brooms, 6 hand scrapers, 1 h. d. flush mach., road grader & tractor	Concrete Brick	Flusher Broom
Iowa						
Cedar Rapids	5	10	55	144 hand brooms, 3 motor-driven mach. brooms, 16 can carrisrs, 1 mot.-dr. flush mach., 2 h. d. sprink. wagons, 1 squeegee, 7 dirt wagons, 1 snow plow	Bit., conc., br., wood, res. Bus. dist.	Flusher—sanitary and speedy White wings
Ottumwa	1	1	..	12 hand brooms, 1 h. d. flush mach., 4 dirt wagons, 1 snow plow	.....	.....
Maine						
Augusta	½	..	6	27 hand brooms, 5 hand scrapers, 2 h. d. mach. brooms, 4 h. d. sprink. wagons, 3 dirt carts, 2 snow plows	.....	.....
Massachusetts						
New Bedford	35	..	..	250 hand brooms, 175 hand scrapers, 2 h. d. mach. brooms, 2 m. d. mach. brooms, 1 pickup sweeper, 70 can carriers, 1 h. d. flush mach., 1 m. d. flush mach., 6 h. d. sprink. wagons, 1 m. d. sprink. wagon, 2 squeegees, 1 dirt wagon, 2 dirt carts, 4 snow plows	.....	.....
Missouri						
St. Joseph	10	..	..	½ gross hand brooms, 24 hand scrapers, 1 m. d. flush mach., 4 dirt wagons	.....	Flusher on all
Springfield	..	..	..	6 hand brooms, 2 hand scrapers, 1 h. d. mach. broom, 1 h. d. sprink. wagon, 4 dirt wagons, 4 dirt carts, 1 motor truck	.....	.....
New Jersey						
Orange	5	2	rest	24 hand brooms, 15 hoes, 1 Elgin mach. broom, 1 Elgin pick-up sweeper, 2 h. d. sprink. wagons, 2 dirt carts	.....	Motor sweeper most efficient
New York						
Binghampton	15	3	..	13 hand brooms, 13 hand scrapers, 2 h. d. mach. brooms, 1 pickup sweeper, 6 can carriers, 1 h. d. flush mach., 1 mot-d. flush mach., 1 h. d. sprink. wagon, 2 dirt wagons, 2 snow plows	Bit., conc., mac. Brick, bus. dist.	Pickup sweeper Flusher
Ohio						
Cuyahoga Falls	..	2	..	2 hand brooms, 1 hand scraper, 2 h. d. mach. brooms, 1 can carrier, 1 h. d. flush mach., 1 h. d. sprink. wagon, 1 dirt wagon, 1 dirt cart, 5 h. d. snow plows	Bit., conc., br., mac.	Motor-driven pickup sweeper—economical
Pennsylvania						
Altoona	12	40	..	12 h. brooms, 1 h. d. mach. broom, 1 pickup sweeper, 12 can carriers, 1 m. d. flush mach., 1 h. d. sprink. wagon, 3 dirt wagons, 2 snow plows	.....	Motor-driven flush machine on all pavements
Steelton	3	..	..	15 h. brooms, 1 h. d. mach. broom, 6 can carriers, 1 h. d. sprink. wagon, 1 dirt cart, 4 hand brooms	.....	Hand broom on all—easily handled
Winton	1	..	..	4 hand brooms.	.....	Shovel preferred
Texas						
Eastland	..	3	..	1 h. d. mach. broom, 1 h. d. sprink. wagon, 1 dirt wagon	.....	.....
Port Arthur	2.6	..	4.5	3 can carriers, 1 h. d. flush mach., 1 dirt wagon	.....	Only asphalt
Virginia						
Richmond	13.7	13.3	11	120 h. brooms, 24 h. scrapers, 4 h. d. mach. brooms, 2 m. d. mach. brooms, 2 pickup sweepers, 25 can carriers, 3 m. d. flush mach., 2 h. d. sprink. wagons, 14 dirt carts	Bit., mac., res. dist. Conc. Br., stone, wood, Bus. dist.	Pickup sweeper Pickup sweeper & flusher Horse sweeper & hand broom Hand sweeping

river. When the timber had all been cut off, these basins were no longer used, and since then all kinds of refuse, including garbage, has been dumped into them. The city has men at these dumps to burn such refuse as is readily combustible and to keep the fill graded. These basins are privately owned, but the owners are glad to have them filled in this way, the land being adjacent to a manufacturing district which is extending on to the fills. Large areas are still available for future dumps and this method will probably continue to be employed for a number of years yet.

GARBAGE DISPOSAL

ELLWOOD, INDIANA

At Ellwood, Indiana garbage is buried on farm land by the trench system, the trenches being dug not over 18 inches deep and garbage placed therein not over 10 inches deep, well sprinkled with quick lime and covered up. The dirt for covering is obtained by digging another trench alongside of it. When carefully watched and properly done, this method has proved very satisfactory; but slackness and slovenly work results in exceedingly unsatisfactory conditions and swarms of flies in the hot season.

EASTON, PENNSYLVANIA

The destructor used by Easton, Pennsylvania, for burning garbage and other combustible rubbish during 1921 burned 5,827 tons, of which 932 was collected by private teams and the remainder by city teams. The city team collection cost an average of $2.08 per ton. Labor at the plant cost an average of $1.37½ per ton and the fuel cost 18 cents per ton, while the total maintenance charges averaged 58½ cents per ton. This gives a total cost for collection and incineration of $4.22 per ton. The ashes collected totaled 4,830 loads at a cost per load of $2.83, plus 70½ cents for maintenance. The furnace is a 35-ton Morse-Boulger, which was described in "MUNICIPAL JOURNAL" for December 28, 1910. It is located about one and a half miles from the center of the city.

LEBANON, PENNSYLVANIA

Lebanon, Pennsylvania, makes use of abandoned quarries for disposing of all its refuse. In winter the garbage is mixed with ashes and rubbish and causes no nuisance, but during the summer months some of the dumps have proven objectionable, in which case they have been treated with lime by the city, the collection being made entirely by private individuals.

GALVESTON, TEXAS

The collection and disposal of garbage by Galveston, Texas, was estimated to cost for the present year $57,880, of which $1,800 was for salary of the superintendent, $1,200 for labor at the dump, $5,928 for laborers at the incinerator, $44,016 for the operation of nineteen garbage wagons and four motor trucks, $500 for repairs to the garbage wagons, $1,500 for maintenance of the motor equipment and $2,000 for repairs to the incinerator. The incinerator burns the refuse up to its capacity and the balance is taken to a dumping ground on the outskirts of the city where it is burned.

MILWAUKEE, WISCONSIN

The incinerator at Milwaukee, Wisconsin, has been described by "MUNICIPAL JOURNAL" and referred to by us several times since it was constructed in 1910. This is a Heenan-Froude destructor containing four furnace units each with a rated capacity of 75 tons per 24 hours, based on a mixture of 60 per cent garbage and 40 per cent ashes and rubbish. Each furnace is connected with a 200-H.P. boiler. Garbage, ashes and rubbish are collected separately and the garbage is mixed with the rubbish and some ashes at the incinerator, the proportion of ashes and rubbish being adjusted to best effect the burning of the garbage. Clinker from the incineration is used for filling purposes along the lake shore and the steam generated is used to operate a 35-K.W. steam turbine and generator, current from which is used by the Milwaukee River Flushing Station, which pumps water from the lake for flushing the river. We are informed by Edward F. Petersin, chief clerk, that in order to keep up a uniform steam pressure in the boilers some coal is necessary in addition to the garbage and rubbish. "The present plant is satisfactory in every way, it does exactly what was expected of it; that is, the complete incineration of garbage, causing no nuisance whatever from either smoke or smell. The only objection to the plant is the high cost of operation and maintenance. The cost of collection per ton of garbage for 1921 was $5.79 and the cost of destruction per ton of garbage was $2.62, making a total of $8.41 per ton of garbage for collection and incineration. This, however, does not include any interest on the investment nor depreciation on the plant, but merely actual operation cost." The capacity of the incinerator has nearly been reached and the city is now considering the construction of another or possibly some other method of disposing of the refuse.

BROCKTON, MASSACHUSETTS

In Brockton, Massachusetts, garbage is collected by the Poor Department and fed to hogs at the City Home. During the past five years the appropriations and revenues for this work have been as follows:

1917—Appropriations....	$23,400	—Revenue from sale of Hogs....	$24,849
1918—Appropriations....	26 300	—Revenue from sale of Hogs....	26,531
1919—Appropriations....	30,200	—Revenue from sale of Hogs....	23,691
1920—Appropriations....	38 650	—Revenue from sale of Hogs....	25,519
1921—Appropriations....	37,530	—Revenue from sale of Hogs....	15,108

There are employed in this work twenty men, one truck and sixteen one-horse wagons. Collections are made daily from hotels, restaurants, hospitals and clubs, and weekly from other buildings.

CAMBRIDGE, MASSACHUSETTS

In Cambridge, Massachusetts, nothing but garbage is collected by the municipality. This is sold from a platform in the northern part of the city to hog raisers and farmers living in nearby towns. The current price early this year was 75 cents per cord foot. Revenue realized from the sale is about $15,000 a year and the expense of collection about $80,000. The city uses horse-drawn, tight, wooden carts, holding about two cubic yards.

Recent Legal Decisions

STATE HELD LIABLE TO HIGHWAY CONTRACTOR FOR DAMAGES FOR CAUSING DELAY

A state made a contract for the resurfacing of a highway, knowing that no subbase had been made, and that this was necessary before the top and bottom course could be laid. The contractor was given a certain time to complete his contract, and this was extended by agreement, but for lack of a subbase the contractor was compelled to wait until the following season to complete the work, suffering a loss from the rise in the cost of labor and materials. The New York Court of Claims holds, Beskin v. State, 195 N. Y. Supp. 951, that the state was liable for the damages sustained by the contractor due to the advanced cost of labor and material, under the rule that: "Where the failure of a contractor to complete the work by the time set is due to a default of the owner, the contractor may, without notice, complete the work and recover the additional expense made necessary by the delay." Barnum v. Williams, 115 App. Div. 694, 102 N. Y. Supp. 874, affirmed 190 N. Y. 205, 6 N. E. 386; Mansfield v. New York Central & H. R. R. Co., 102 N. Y. 205, 114 N. Y. 331."

STATUTE RELIEVING HIGHWAY CONTRACTORS BECAUSE OF WAR TIME CONDITIONS HELD UNCONSTITUTIONAL

The Indiana Supreme Court, Hays v. Board of Commissioners of Owen County, 136 N. E. 13, follows its former decision in Davis Construction Co. v. Board, 132 N. E. 629, holding that Indiana Acts 1919, c. 93, p. 475, purporting to relieve highway contractors from the obligations of their contracts because of conditions arising out of the war with Germany is unconstitutional.

COUNTY AND TOWN HELD NOT LIABLE FOR CONTRACTOR'S UNAUTHORIZED RELOCATION OF TRACKS ON PRIVATE PROPERTY

The construction, maintenance and control of highways is a governmental function. For convenience of administration counties and towns were organized, and to them were delegated certain powers and duties, well defined and limited by statute, among which are some duties in the construction, maintenance and control of highways, in discharging which they are performing a governmental duty, and their officers acting therein are the agents of the public and the state. The towns and counties are as exempt from the unauthorized or wrongful acts or contracts of their officers in this respect as is the state. The towns and counties and their respective officers can raise and expend public moneys for such purposes and in such manner only, and can obligate the town and county on such contracts only, as the statute specifically authorizes. They have no general powers to make contracts. If a contract is not within the power granted by statute to the town or county to make, the action of the town board or the board of supervisors, authorizing or assenting to it, does not confer a binding obligation on the town or the county.

Applying these principles, the New York Appellate Division holds, New Paltz H. & P. Traction Co. v. Ulster County and Town of Lloyd, 195 N. Y. Supp. 623, that where plans for a highway improvement required a traction company's tracks to be relocated within the highway limits on the northerly side thereof, and, although the county had not complied with Section 148 of the Highway Law, requiring land to be acquired, prior to advertisement for proposals, for a deviation from the existing highway, the contractor located the tracks on the property of an abutting owner, the contractor was a trespasser, but for his trespass neither the state, county, nor town was liable. The contract for the construction of the highway was made by the state commission, which retained full control of the work thereunder. The county and the town were without authority to make such a contract. The fact that under the statute towns and counties are to bear certain expenses in acquiring lands for a highway does not put upon them implied liability for contracts made without authority of the statute.

NECESSARY IMPROVEMENT OF HIGHWAY NOT SUBJECT TO INJUNCTION BECAUSE OF DAMAGE TO PRIVATE OWNER

The Minnesota Supreme Court holds, Dynes v. Town of Kilkenny, 189 N. W. 439, that a court should not enjoin a necessary improvement of a highway merely because it will cause damage to a private landowner. The recovery of the compensation guaranteed by the Constitution is the method designed to make the landowner good. Nor should a court enjoin the removal of soil which may contain seed or roots that will grow into a nuisance where recovery of damages is an adequate remedy and the expense and inconvenience of undoing the work far outweighs the damage done.

RECOVERY BY CONTRACTOR FOR PART PERFORMANCE OF UNCOMPLETED CONTRACT AND FOR EXTRA WORK

Where a road contractor has failed to complete his contract with the county in time, and subsequently abandons the work, which is taken over by the county, the Oregon Supreme Court holds, Feldschau v. Clatsop County, 208 Pac. 764, that the contractor is entitled to recover the contract rates for the work done under the contract, less any damages the county may have sustained by reason of his failure completely to perform the contract. This rule is sustained by various decisions in other jurisdictions.

Where the contract and the consideration are both entire, and no price is stipulated in the contract to be paid for anything less than complete performance, and there has been a part performance by one party to the contract which has been of benefit to and has been accepted by the

other, the rule in Oregon is that the party who has partly performed his contract is entitled to recover on quantum meruit for the part performed, less such damages as the other party may have sustained by reason of his failure to complete performance. But where the contract stipulates the rates and prices to be paid for that which has been done under the contract, then the right of such party to recover for part performance is limited to the rates and prices fixed by the contract. In the first instance the party is permitted to recover on quantum meruit for the reason that in the nature of things there can be no other measure of recovery than that of reasonable value; while in the latter case the parties are and should be bound by the rates and prices which they themselves have agreed should be paid therefor.

Where a contractor has been compelled to perform services outside of his contract, and not within the contemplation of the parties at the time the contract was entered into, if there is no provision in the contract stipulating the amount that he should be paid for such services, he is entitled to recover on quantum meruit.

Where a road contractor has only partly performed and has been excused from further performance by prevention, or by the repudiation or abandonment of the contract by the county, he may recover at the contract rates the value of the services rendered, or he has his action on the contract for damages.

COST OF SPECIAL IMPROVEMENTS AND ITS APPORTIONMENT

The Kansas Supreme Court holds, Buckwalter v. Henrion, 208 Pac. 645, following Bailey v. City of Wichita, 108 Kan. 282, 284, 194 Pac. 928, that a reasonable sum to cover items of incidental expenses necessarily incurred in constructing special improvements may lawfully be included in the cost thereof.

Where the cost of special improvements on city streets is fairly apportioned and fairly assessed against the abutting properties benefited thereby, in compliance with a statute fairly designed to render approximate justice to the property owners concerned, the Kansas court holds that there is no confiscation or other breach of constitutional law, although the assessments in some instance may aggregate more than the current market value of the properties taxed therefor.

TIME OF NOTICE TO OWNER OF ASSESSMENT FOR LOCAL IMPROVEMENT

Holding that the final notice of hearing for the confirmation of assessments and the privilege of filing objections thereto, as provided by the statute, is sufficient notice to owners of assessments for local improvements, the only notice of the preliminary proceedings having been by publication of the resolution of intention, the Wyoming Supreme Court says, Bass v. City of Casper, 208 Pac. 439, that all rules of apportionment of assessments are or should be based upon the underlying principle that the property has been benefited to the extent of the assessment, whether the apportionment is made by a rule previously fixed by the Legislature, on a purely mathematical basis, or is made by the local governing board according to the benefits conferred. An owner has no constitutional right to say as to whether an improvement resolved upon by the municipal authorities shall be made. This and other questions must in the interests of all, necessarily be largely left to the discretion of the governing board of the municipality. He is interested in the one vital question of the charge, the assessment made upon his property. In the legality of that charge is necessarily involved the legality of all that precedes it and of which it is the consequence. Adams v. City of Roanoke, 102 Va. 53, 45 S. E. 881. Hence, it would seem clear that no matter what rule of apportionment is used, if he is able to test the validity and the justness of the assessment at some stage of the proceedings, he is fully protected in his constitutional rights, without making the time when he shall have the opportunity so to protect himself of the essence. And this seems to be the view of the authorities.

COST OF REPAVING STREET INTERSECTIONS

Under the Kansas statute of 1921, Session Laws, ch. 118, providing that one third of the entire cost of repaving a street is to be borne by the city at large, and the remainder to be assessed against the benefited property, the Kansas Supreme Court holds, Weigand v. Lester, 207 Pac. 651, that the cost of paving the street intersections is not to be segregated from the total cost nor added to that part of the burden imposed by the statute on the city at large.

WAIVER OF RIGHT TO CUT OFF WATER SUPPLY FOR NON-PAYMENT OF OLD BILLS

The Court of Appeals of Maryland holds, Mayor and City Council of Baltimore v. Tickner, 118 Atl. 136, that where the city, after a consumer's bills for water had gone unpaid for three years, owing to his protests that the rates were too high, made a new contract to supply the consumer at a lower rate, and received the charges thereunder, it waived its right to cut off the water supply for the non-payment of the bills for the three previous years, and was confined, in the collection of these charges, to such other remedies as it had under the law.

CONSTRUCTION OF AGREEMENT AS TO PATH UNDER RAILROAD TRACKS

By agreement between a town and a railroad company a petition by the latter for the laying out of a public path for pedestrians under the railroad tracks and the decree thereon provided that the town should assume the cost of future changes. The Massachusetts Supreme Judicial Court holds, Directors of Boston & Albany R. Co. v. Town of Brookline, 136 N. E. 747, that the town could lay out the path only in accordance with the decree, and the agreement did not bargain away or infringe upon the exercise of the town's right to discontinue the way if in the future such action should be deemed advisable.

PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

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Municipal Pavement Repairing in Newark

Modern plant built in 1921 turns out asphalt binder and surface at about half the cost by an old plant requiring more hand work. Description of the new plant.

By James W. Costello *

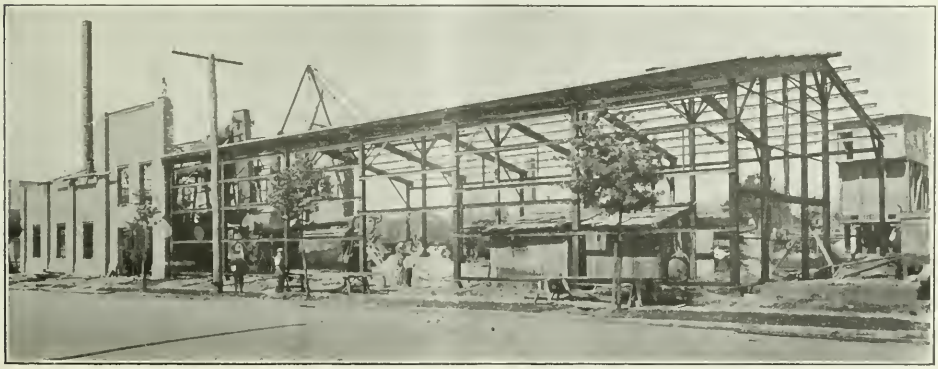
Previous to the fall of 1913 all repairs to asphalt pavements in the city of Newark, N. J., were made by means of the contract system, i. e., the city contracted for repairs to its asphalt streets for a stated price per square yard of repairs made. The city at that time had approximately 1,254,000 square yards of bituminous pavements to maintain. The contract price for repairs during 1913 was $1.18 per square yard. In 1912, the last full year of such repairs, 54,541 square yards of repairs were made at a cost to the city of $1.17 per square yard.

During 1913 the city erected a municipally-owned asphalt repair plant with a rated capacity in eight hours of 1,000 square yards of wearing surface 2 inches thick after compression. The plant was the portable, drum mixing type, Warren Brothers manufacture, set up as a stationary plant. This outfit took care of our requirements for eight years.

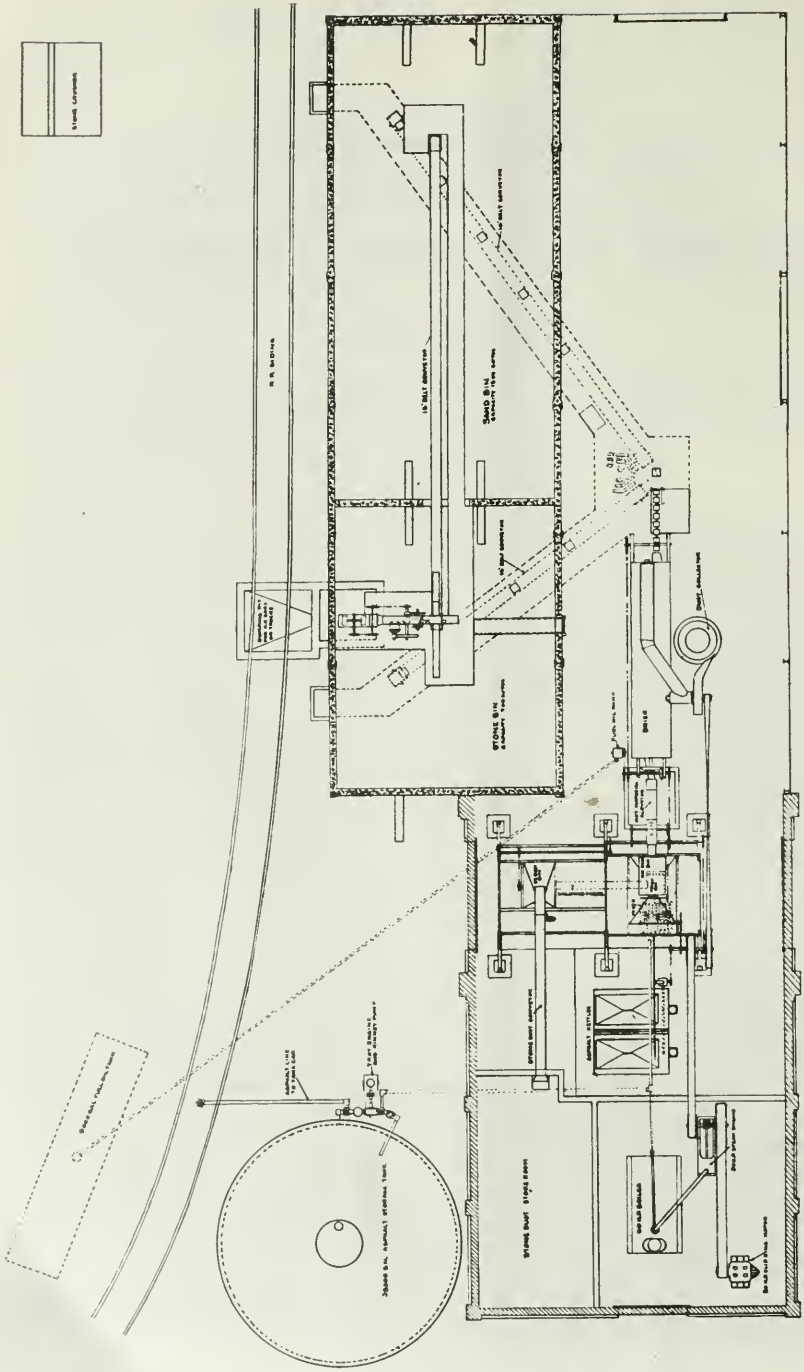
*Chief Engineer, Division of Works, Newark, N. J.

The first full year of our own repairs was during 1914. During the year 33,677 square yards of repairs were made at a cost of $1.29 per square yard. In 1915, 37,458 square yards of repairs were made at a cost of $1.10 per square yard; 1916, 51,606 square yards at $1.03 per square yard. The cost of repairs per square yard the first year the municipal plant was in operation was greater than the cost of the same work under contract, but as is seen this unit cost decreased in subsequent years and became less than the contractors' price. This high cost the first year of municipal operation is attributed to the inexperience of most of the men and crudeness of methods which afterwards were improved. It is also significant that the yardage of repairs required decreased considerably.

In making our own repairs, much better service has been obtained than by contract. The contractors made their repairs at certain periods of



ASPHALT PLANT DURING CONSTRUCTION



PLAN OF MUNICIPAL ASPHALT PLANT OF NEWARK, N. J.

the year and did not maintain a repair gang at work for the city the year round. This always tended to increase the amount of repairs needed, as holes and depressions were not taken care of as promptly as is now done with our own organization, which is busy continuously throughout the whole working season and makes such repairs as are needed, thus preventing the formation of a large hole or depression from a small one before attention is given same. Furthermore, there was always present a tendency on the part of the contractor to extend the "cutting out" beyond the point necessary to repair a hole and the taking out of depressions that did not really require attention.

The need for a larger and better plant had been recognized by the department for some time. The repair bureau does considerable new work, resurfacing of telford streets, new asphalt pavements, work for outside parties, etc. We found, as more of this work was being done by the department, an ever increasing need for a more modern plant of increased capacity.

The need for a new and modern plant and the advisability of extending the operations of our asphalt organization was recognized by Director Thomas L. Raymond, of the Department of Streets and Public Improvements, and he allowed the appropriation necessary to erect and equip the plant described below. The plans were made in 1920, the actual construction taking place during 1921.

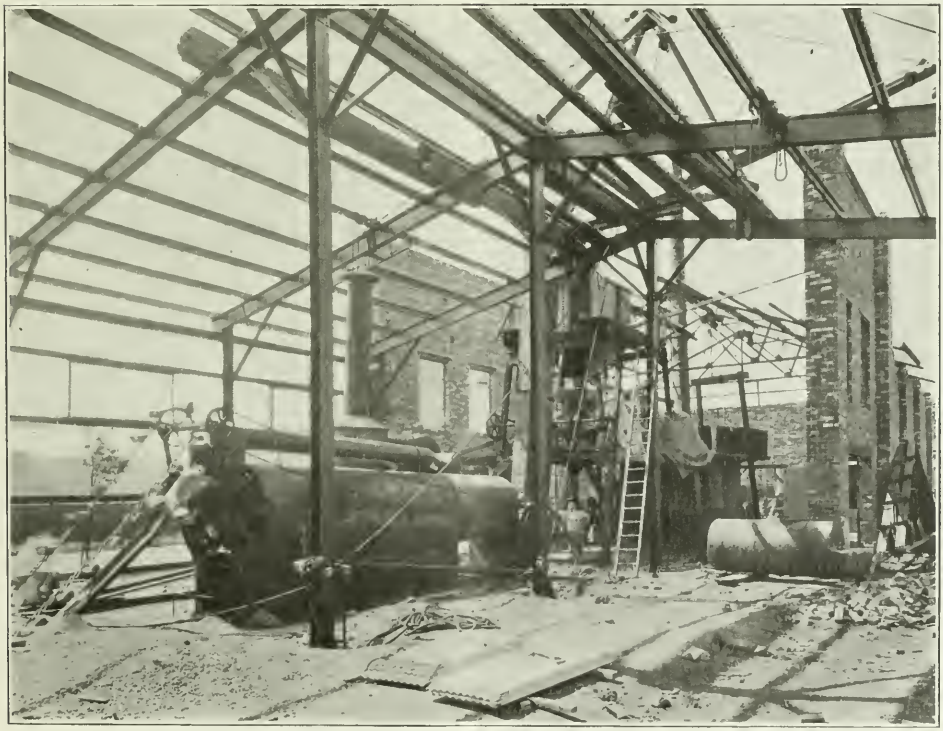
George W. Andress, principal assistant engineer, Division of Works, who has charge of the Bureau of Street Repairs, was placed in charge of the general layout, design and construction work required. The plant has been in operation during all of 1922.

THE NEW PLANT

The asphalt machinery proper, consisting of drier, mixer, heating kettles, 60 h.p. boiler, 50 h.p. engine, with supporting tower and other appurtenances, was purchased from Warren Brothers Company, and has a capacity of 200 square yards per hour of two-inch wearing surface, after compression.

Additional features of the plant are a brick and steel building covering same, reinforced concrete storage bins for sand and stone, conveyors for handling sand, stone and limestone dust, asphalt storage tank with appurtenances, a 50 h.p. electric motor, an electrical pyrometer, etc.

The building covering the plant is of brick and steel construction, with corrugated iron roofing supported by steel roof trusses. Part of one end and one side is of corrugated iron, while one-half of the portion constructed of steel is enclosed by



NEWARK'S MUNICIPAL ASPHALT PLANT DURING CONSTRUCTION

STREET SIDE, MUNICIPAL ASPHALT PLANT

vertical reinforced concrete slabs between the columns, making the sand and stone storage bins.

We have provision for delivery of sand and stone by rail or motor truck. The material is dumped from either car or truck into a receiving pit from which it is fed by gravity through a rotary feeder into a 48-foot center, continuous, vertical bucket elevator. From this elevator the material is discharged into a steel enclosed chute and the stone passes directly from the chute into the storage bin. By means of steel flap gates, with hand operating levers, the stone is discharged through branch chutes into different portions of the bin.

The sand discharges from the steel chute leading from the elevator into a horizontal belt conveyor 16 inches wide, which operates over the top of the sand bin. This conveyor is 60 feet long between centers. A hand movable, steel plow operating on a small rail track permits discharge of the sand at any point desired along the belt. The rotary feeder to the elevator, the elevator and the overhead belt conveyor are all operated by means of a 7½ h.p. G. E. motor, gear connected, with starting devices on the floor level of the plant and on the switchboard, and with stopping switches located at the motor on the working platform, at the outside of the building near the dumping pit, and at the starting point on the switchboard. These switches enable a workman to stop the machinery, in case of an emergency, at any one of three different points. The conveyors, elevator and belt, are designed to deliver fifty tons of matrial an hour and will do so under satisfactory working conditions.

Moist asphalt sand is one of the most sluggish materials there is to handle; it will stand vertical when cut in the pile by spade or shovel. Some difficulty was met by the sand adhering to the sides of the chute leading from the vertical elevator, but this was obviated by means of a small hammer consisting of a maple block about 4 x 4 x 8 inches, which is attached to the upper drive shaft of the elevator, and by means of an automatic release gives sharp blows to the under side of the chute, at the rate of about eight per minute. The shock is slight but sufficient to prevent the clogging of the chute.

The materials are delivered from the storage bins to the drier by means of two reclaiming conveyors, operating in tunnels underneath the bins, receiving power from a 5 h.p. G. E. motor, gear-connected, with clutches so that either one or both may be run at a time.

Under the sand bin there is a belt conveyor 16 inches wide and 54 feet long between centers, and underneath the stone bin there is a similar conveyor 39 feet centers. There are four openings, 12 x 12 inches, through the roof of the tunnel underneath the stone bin, and five openings underneath the sand bin, the under sides of which are provided with adjustable gates. In running stone for binder, we find it requires the presence of only one man, who is in the tunnel, to deliver the stone from the storage bin to the drier; he merely opens the gate to discharge the required amount, which is conveyed by the belt to the cold material elevator pit, from where it is picked up by the elevator and delivered to the drier. The operation of the sand reclaiming conveyor is similar to that of the stone, except that we find the moist sand is hard to regulate in quantity at the gate, and we therefore have workmen (two at the most) feed the sand to the conveyor from the floor level of the bin with hoes or shovels.

The stone dust conveyor is of the bucket type and operates from the stone dust storeroom to the storage bins, supported at the upper platform on the same level with the hot sand bin. The conveyor and bin are entirely enclosed, thus preventing the blowing about of the material. The stone dust bin has a capacity of about 140 cubic feet and the storeroom has a capacity of approximately 4,000 bags. Operating underneath the dust bin and discharging into the weigh box is a 9-inch screw conveyor. This screw is connected to the main shafting of the plant and is set into operation by engaging a friction clutch by means of a hand-operated lever.

Asphalt cement is received at the plant in tank cars and is pumped therefrom into a 35,000-gallon capacity storage and heating tank. The tank is of steel construction with concrete floor. The storage compartment has about 32,000 gallons capacity and is 31 feet in diameter. The actual heating compartment is 6 feet in diameter and holds about 3,000 gallons; it is set in a pit, the floor of which is about 4 feet below the level of the floor of the storage compartment. The storage tank contains one square foot of coil heating surface to every 200 gallons of asphalt cement and the heating compartment contains one square foot of coil heating surface to every 12 gallons of asphalt cement. Only when the weather is cold, or the plant is running to full capacity, does it become necessary to admit steam to the outer coils. There is, with the exception just stated, always sufficient radiation of heat from the inner tank to produce the required flow of asphalt from the outer to the inner tank. A Kinney 6-4-6 asphalt pump connected to a Troy 5 x 7 vertical steam engine is used for conveying the asphalt cement from tank cars to storage tank and from

heating tank to the plant melting kettles or weigh bucket direct.

The plant was originally operated by means of a 50-h.p. steam engine connected up to a 60-h.p. boiler. Rather than increase the boiler capacity to take care of the additional load necessitated by the asphalt tank, we purchased a 50-h.p. Westinghouse slip-ring motor with a 50 per cent. variable speed control to operate the asphalt plant, thus leaving the entire capacity of the boiler for asphalt heating and pumping, and to operate the oil burners. Eventually, we intend to install steam coils in the two 24,000-gallon melting tanks of the plant.

The electric motor drives to the flywheel of the steam engine, which originally was used to operate the plant, and by disconnecting the connecting rod of same a very good countershaft is obtained without extra expense. The steam engine is kept connected to the boiler and may be used to operate the plant should a breakdown of the motor make it necessary to do so.

The boiler, engine and motor are located in a power room separately enclosed from the rest of the plant. The drier is heated by fuel oil burners, the fuel oil being pumped from a 9,000-gallon buried steel storage tank.

The temperature of the sand as it leaves the drier is determined by a Brown electrical pyrometer, the indicator of which is placed at a location convenient to the sand bin and the oil burner operator.

The cost of plant and equipment was as follows:

Mixing plant and machinery	$26,000
Building	19,670
Conveying system for sand and stone	15,250
Storage bins for sand and stone	8,380
Asphalt heating and storage tank	4,150
50-h.p. electric motor	1,860
Conveying system for stone dust and appurtenances	3,000
Incidental costs	1,690
Total cost	$80,000

COMPARISON OF PLANTS

A comparison of the costs of handling materials by the improved methods of our new plant with the costs of doing the same work with our old plant, where practically everything was by hand labor alone, is very interesting. By reason of our large sand storage capacity, whereby we can purchase sand in scow load lots instead of smaller quantities as heretofore, we effect a saving of about 15 cents per cubic yard, this being the amount the dealer saves by eliminating yard storage. The cost of conveying sand from storage to the drier in our new plant is about 20 cents per cubic yard as compared with about 34 cents per cubic yard for the same work in the old plant. Our contract price of asphalt cement during 1922 (purchased from the Texas Company) was $11.08 per ton less, delivered in tank cars, than it was during 1921 delivered in barrels; or the cost was $16 per ton placed in the heating kettles during 1922, as compared with $34 per ton placed in the heating kettles during 1921; the saving being produced by the reduced cost of A. C. in bulk shipments, and the mechanical handling.

In running stone for binder the cost is about 60 per cent. less than the cost of the same work when running binder with the old plant. Greatly reduced costs are had also in the handling of limestone dust, the exact figures not being available at present. The actual costs of production in our new plant when running somewhat below capacity, figured over a period when operating on contract work, were $3.65 per ton for binder and $4.88 per ton for top, the figures including only labor, material and supervision. We believe we can better these figures this year.

ORGANIZATION AND OPERATION

The asphalt plant organization consists of one superintendent, a stock clerk, an engineer, two plant men and five to ten laborers depending upon the extent of operations. As a comparison, the organization of our old plant when running to capacity consisted of one superintendent, one stock clerk, two plant men and eleven laborers, with an output of about 100 square yards per hour of 2-inch wearing surface after compression. When men are not needed in the operation of plant or handling materials we place them at the stone crusher, where we convert into crushed stone, old granite blocks, bridge stones and other old material suitable for crushing which cannot be used elsewhere, received from streets undergoing improvement.

In all our strictly new work we obtain contracts after bidding in competition with outside firms. The department enters into a contract with the city the same as though it were an outside party and is bound by the same conditions, and its work is inspected by the same construction bureau. We have during the past year made several thousand dollars, which is turned back into the repair fund for general street maintenance. Our work is conceded to be of first class quality and we have no trouble competing with contractors. We feel also that the competition which we create tends materially to reduce the costs of bituminous pavement work in this city, and we have received considerable favorable comment through the press and elsewhere for our activities.

It is expected that by the expansion of the work of the department along this line the bureau of repairs will become partially self-sustaining, and the asphalt plant prove to be a very profitable investment.

Note: The annual report for 1921 gives the following cost of repairs by city plant to pavements out of guarantee:

Kind of Pavement	Surface Layer Sq.Yds.	Surface Layer Per Sq.Yd.	Concrete Base Sq.Yds.	Concrete Base Per Sq.Yd.
Sheet asphalt	51,499	$1.8126	3,979	$2.3313
Granite block	27,815	1.5262	1,131	2.6651
Brick	6,679	3.4968	3,236	4.1820
Asphalt block	126	4.2169	59	2.9908
Wood block	4,168	4.4164	3,487	1.5341*

*Replacing 1 inch mortor cushion on existing concrete base.

Concrete Mixers and Mixing

By F. S. Besson *

Brief treatise on mixers, their classification, power, traction, distribution system, and method of use.

Mixer Types and Costs. The designs of mixers made by different manufacturers vary greatly, but any of the half dozen or more standard makes advertised in the engineering periodicals are satisfactory. While it is well known that there are three kinds of mixers—batch, continuous and gravity—the batch mixer is used for pavements practically to the exclusion of the others. Batch mixer outfits are divided into two classes known respectively as "S" and "E." The "S" class, having side loading and side discharge and no self-traction, are usually confined to general construction work, while paving mixers belong to the "E" class, generally having self-propelled traction with end loading and end discharge. Practically every construction mixer is furnished either on trucks or on skids, there being no difference in the machine itself, but in the equipment furnished with it. Data pertaining to the two classes of mixers, "S" and "E," are given in the accompanying table:

Data Pertaining to Class S and Class E Mixers

Size of Mixer	Horse Power	Class S: Mixer on Skids Weight Lbs.	Class S: Mixer on Skids Height Feet	Class S: On Trucks with Power No Traction No Charging Skip Weight Lbs.	Class S: On Trucks with Power No Traction No Charging Skip Length Feet	Class S: On Trucks with Power No Traction No Charging Skip Width Feet	Class E Paver Weight Lbs.	Class E Paver Width Feet
3	1½-2½	500 to 1,000	3 to 4	1,000 to 1,500	5 to 6	4	....	.. ..
4	3-4	800 to 1,500	3 to 4	1,500 to 2,000	6 to 8	5	....	.. ..
7	5-7	1,500 to 3,000	4 to 5	3,000 to 4,500	8 to 10	6 to 7	7,000 to 8,000	6 to 7
10	8-10	2,500 to 4,000	5 to 6	5,000 to 6,000	9 to 11	6 to 7	14,000 to 18,000	7 to 8
14	8-14	4,000 to 6,000	6 to 7	7,000 to 9,000	11 to 12	6 to 7	18,000 to 22,000	8 to 9
21	12-18	6,000 to 8,000	7 to 8	9,000 to 12,000	12 to 13	6 to 7	20,000 to 26,000	9 to 10
28	18-25	7,000 to 9,000	8 to 10	12,000 to 14,000	13 to 15	7 to 8	30,000 to 35,000	10 to 11
56	35-45	14,000 to 16,000	9 to 12	....	.. ..	.. ..	....	.. ..
112	80-100	40,000 to 55,000	15 to 20	....	.. ..	.. ..	....	.. ..

Note: Horse power figures apply to electric or steam. A gasoline engine should be provided with a large excess of power in order to allow for dirty spark plugs, too much oil, worn pistons, etc.

The tabulated weights indicate in a general way that some machines are of more rugged construction than others, and accordingly, they stand up better under heavy work. To obtain a rough approximation of the cost (1922) of the different sizes from the smallest mixer to the largest, a cost of from 20 to 25 cents per pound may be assumed, to which must be added for delivery 2 or 3 dollars per hundred pounds, or whatever the freight charge may be. Generally, the smaller machines cost less per pound than the larger and more efficient ones. In choosing a mixer, its first cost is not of most importance—operating and maintenance costs must be considered:—in fact, requirements for profitable mixer service are, in order of importance, (1) endurance; (2) speed of operation; (3) mechanical simplicity; (4) operating simplicity; (5) service in purchase of repair parts, and (6) first cost.

Class "S" Mixers. Class "S" mixers on skids are illustrated in Figs. 1 and 2. Practically all manufacturers turn out class "S" mixers for skid mounting. They are on the market from the smallest size, No. 3-S, to the largest, No. 112-S. Power and secondary equipment and attachments for use with the mixer can be obtained with it, but often mixers on skids are bought alone and fitted into existing plants, whether the power be gasoline, steam or electric.

Mixers on trucks are illustrated in Figs. 3 and 4. Generally, manufacturers mount all styles of their mixers on trucks, except in the very largest sizes. The type shown in Fig. 1, when mounted on trucks, is popular for small work. It may be noticed that the batch is both fed into and discharged from the one drum opening. Small mixers such as this are generally operated by gasoline motors, and though of comparatively light weight they are well worth their cost. For heavier types of mixers there are two methods of discharging. Some receive the charge into the drum at one end and the drum is tilted in order to discharge from the other end, an example being the mixer illustrated in Fig. 2. Other mixers have drums that do not tilt, but discharging is accomplished as illustrated in Fig. 3, by means of a discharge chute, which is thrown into or out of the drum opening.

It is not uncommon to find the mistake being made of using a class "S" mixer where class "E" should be used. For some work, as for instance in a narrow alley, the side-discharge truck mixer is very unhandy, and in such cases it is found that barrow men, at much expense, wheel aggregate long distances to the mixer and concrete long distances from it. Some small mixers, especially of that type shown in Fig. 1, are

*Major, Corps of Engineers, U. S. Army, Assistant to the Engineer Commissioner of the District of Columbia.
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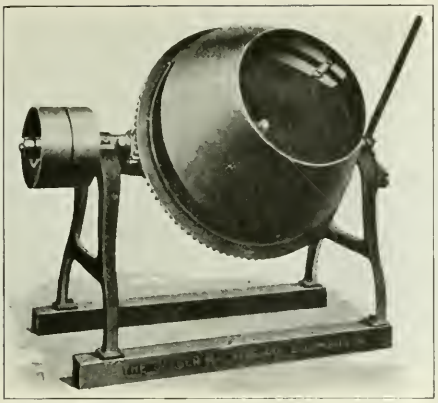


FIG. 1—AN ECONOMICAL TYPE OF MIXER FOR SMALL WORK, USUALLY LIMITED TO NO. 7 SIZE OR SMALLER. CAN ALSO BE OBTAINED MOUNTED ON TRUCKS AND WITH LOADING SKIP

mounted so that they can be rotated on the trucks and discharge either to the side or to the end, thus combining in one machine both class "S" and class "E" principles.

Class "E" Mixers. Class "E" mixers are designed primarily for paving work. An example is illustrated in Fig. 5. Some manufacturers are confining their pavers to three sizes, Nos. 10-E, 14-E, and 21-E. Others make also, sizes 7-E and 28-E. No. 21-E is the largest that is economical for ordinary work. It mixes concrete about as fast as the best of organizations can deliver materials and handle the concrete as discharged. The No. 28 size is suitable only for extraordinary paving projects; for example, such as have been contracted for recently by one or two states.

Power. For portable types of mixers generally either gas engines or steam are used. Electric motors are often used for stationary mixers. Gas engines are invariably of higher rated horsepower for each size of mixer than either steam or electric. Several years ago steam was greatly favored for large pavers. Lately high-grade, reliable, and economical gasoline units have been perfected for pavers and are now a popular choice. Steam is objectionable in cases where conditions relative to the employment of steam engineers and firemen are so unreasonable as to make operation costs excessive. If a gas engine is used for a large mixer it should be of four cylinders and have plenty of excess power. Good service will then be rendered, and that which is not always true for steam, no trouble will be had in obtaining mechanics to operate the engine. The choice of a gas engine, of course, does away with the trouble of handling heavy fuel, getting up steam, firing the boilers, cleaning boilers, etc.

Traction. Multiple tread traction as illustrated in Fig. 5 handles better on the job and does not sink into soft ground as readily as do wheels, though the latter give swifter movement from job to job, which is an important element in city work because generally a season's work is made up of a large number of small items widely distributed throughout the city. Even with wheels, however, paver speeds generally are less than 1½ miles per hour. If hauled as a trailer behind a truck at greater speeds, the machine is unduly shaken and jolted. This can be corrected by mounting the mixer on a truck equipped with rubber tires and motor vehicle bearings. If a trailer is made with motor truck wheels and bearings and a chassis that can be tipped, so that a paver can crawl aboard by its own power and be hauled as illustrated in Fig. 6, then much time can be saved, wear and tear greatly reduced and multiple tread traction used to the best possible advantage.

Boom and Bucket. Now that the use of relatively dry concrete is firmly established, boom and bucket distribution is becoming more commonly used, though a chute is cheaper in first cost and cheaper in maintenance. Depending upon the size of the machines, booms range from 15 to 20 feet in length. With some mixers cer-

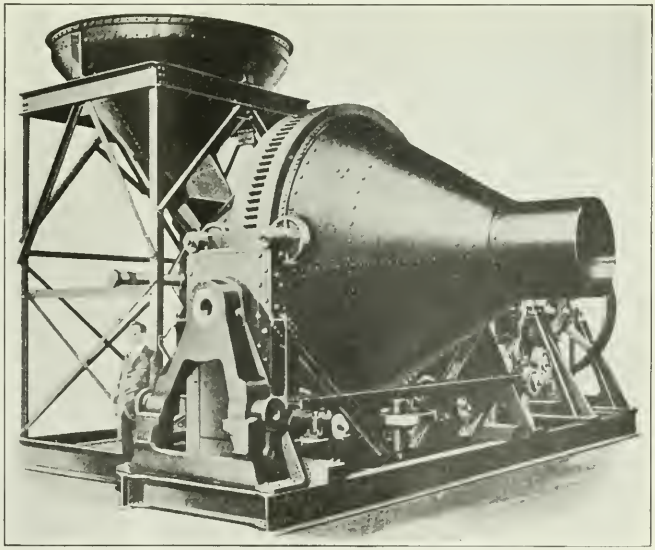


FIG. 2—A HEAVY TYPE OF MACHINE, OBTAINABLE UP TO AND INCLUDING THE NO. 112 S SIZE

tain faults have been noticed. A purchaser should be sure that the boom can be swung when out of horizontal when working up or down hill, that the bucket is full-batch capacity, and that it can be handled for the full length of the boom without overbalancing the machine. Deficiencies as to these points probably have been corrected in all recent mixer models.

Water. The importance of maintaining the proper consistency being apparent, the necessity of having a measuring gauge regulating the amount of water for each batch is readily realized. The necessity of taking care of such variable factors as rain-soaked or sun-dried aggregates must, however, be recognized and the water lock required by the Joint Committee's specifications should not be made such a permanent fixture as to make it difficult to compensate for these variables.

In addition to the provisions as to measuring water, the Joint Committee proposed:

Water. Water for concrete shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substance.

Time of Mixing. The time of mixing is an important element, and as it largely controls the output of the mixer, and therefore the cost of the concrete, it needs careful consideration. Tests with various batch mixers at present on the market show a rapid increase in strength for the first minute concrete is mixed, and a smaller increase for the second minute, after which the increase continues smaller as the time of mixing increases. The increase in strength appears whether the concrete is tested at 7 days or after the lapse of considerable time. While some engineers now specify a 1½ minute mix, the great majority of contractors appear to believe that the excess cost thereby entailed over

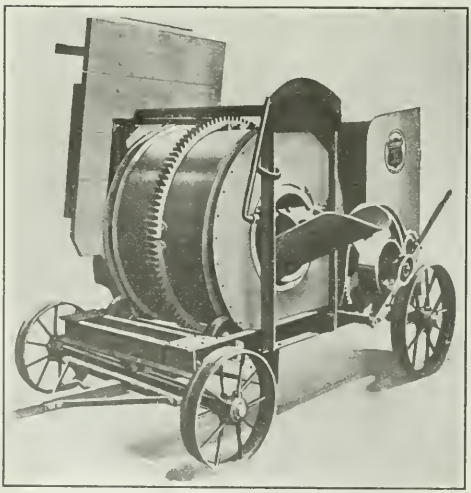


FIG. 3.—A LIGHT-WEIGHT MIXER MOUNTED ON TRUCKS AND EQUIPPED WITH A TIMBER PLATFORM FOR DIRECT CHARGING FROM BARROWS

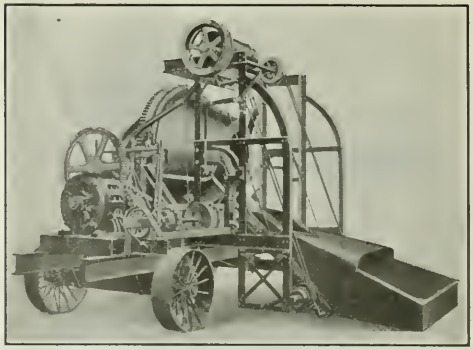


FIG. 4.—A HEAVY-DUTY TYPE OF MIXER

that for a minute mix is not justified by the extra strength obtained. The addition of a little cement for extra strength should be given consideration in place of lengthening the time of mixing.

It may be that in the near future an improved mixer will be developed that will give full strength concrete in less than a minute. Such a machine would add much to the economy of mixing. There is now no question, however, as to fixing one minute as a minimum. If less time is specified, water is not worked through the mass as it should be, and in order to get this consistency, the mixer man may use more water than should be permitted. A batch meter to insure the full mixing time after all the ingredients, including the water, are in the drum, is absolutely necessary. The Joint Committee proposed:

Time of Mixing. The mixing of each batch shall continue not less than 1½ minutes after all the materials are in the mixer, during which time the mixer shall rotate at a peripheral speed of about 200 feet per minute. The volume of the mixed material per batch shall not exceed the manufacturer's rated capacity of the mixer.

(*To be continued*)

Department Aid to Highway Contractors

A notice was sent out early in January by J. S. Watkins, division engineer of the Kentucky State Highway Department, notifying all contractors of an opportunity that would be furnished them to inspect in his company's road for which a contract was to be let on January 23d. The notice was as follows:

HIGHWAY DEPARTMENT NOTICE

To All Contractors:

Please be advised that on Wednesday, January 17, I will go over the Barbourville-Corbin road in Knox County, which is advertised for letting on January 23. Those of you who are interested in bidding on this project will meet me at the Jones Hotel in Barbourville, Ky., on the above mentioned date at 9 a. m., at which time we will proceed on horse-back or in hacks toward Corbin, Ky. The entire project should be thoroughly covered in five hours' time. I would appreciate it if those of

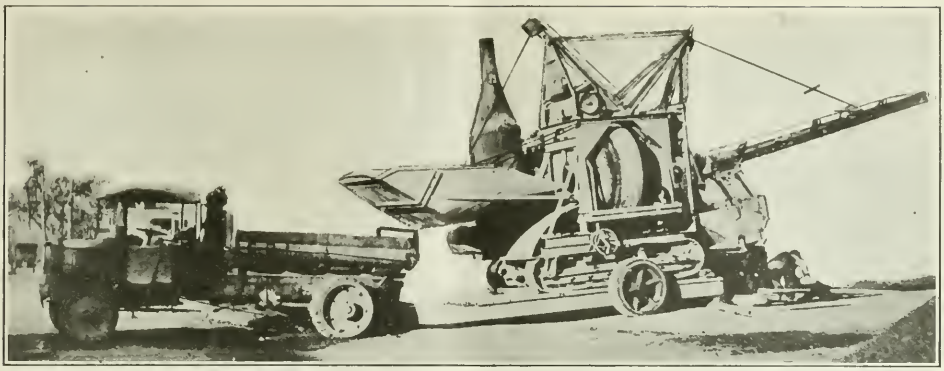


FIG. 6—A 21-E MIXER LOADED ON A LOW TRAILER FOR TRANSPORTATION FROM JOB TO JOB

you who will be present on this trip, will kindly notify this office by January 15 so that arrangements can be made for horses.

J. S. WATKINS, Div. Engineer.

Weight of Pavement Reinforcement

There is a wide variation in the specifications for reinforcement used in concrete pavements, the minimum weight being 25 lbs. per hundred square feet and the maximum 90 lbs. In New York State alone there are five different weights, namely, 25, 30, 40, 56 and 60 lbs. per hundred square feet. However, this year New York adopted 63 lbs. as standard. This information was given by W. C. Kuhn, of the American Steel and Wire Company, in a paper before the New Jersey Highway Association. In addition, he gave figures concerning a number of other states.

Pennsylvania calls for 56 lbs. per 100 square feet, which is increased from the former specifications of 25 lbs., and the state is considering still further increasing the standard to 65 lbs. In the south 25 lbs. was the usual specifications in the few cases where reinforcement was used. In the middle west the specifications vary from 30 lbs to 55 lbs.

In New Jersey from 34 to 56 lbs. have been specified for "single reinforcement" and a total of 90 lbs. for double. Forty-five lbs. was used in the Fort Lee Turnpike across the meadows because of the soft ground over which the road was constructed, and one section 3,500 ft. long has been down since 1917 and a second section 1,000 ft. long since 1919, and there are only one or two cracks in the entire road. Mr. Kuhn said that there is a tendency to increase the New Jersey County specifications to 56 lbs., but he does not see the logic of increasing the cost of the road to this amount since practically all county roads are in the secondary system and not subject to the heavy traffic of the state roads where the 56 lbs. reinforcement is used.

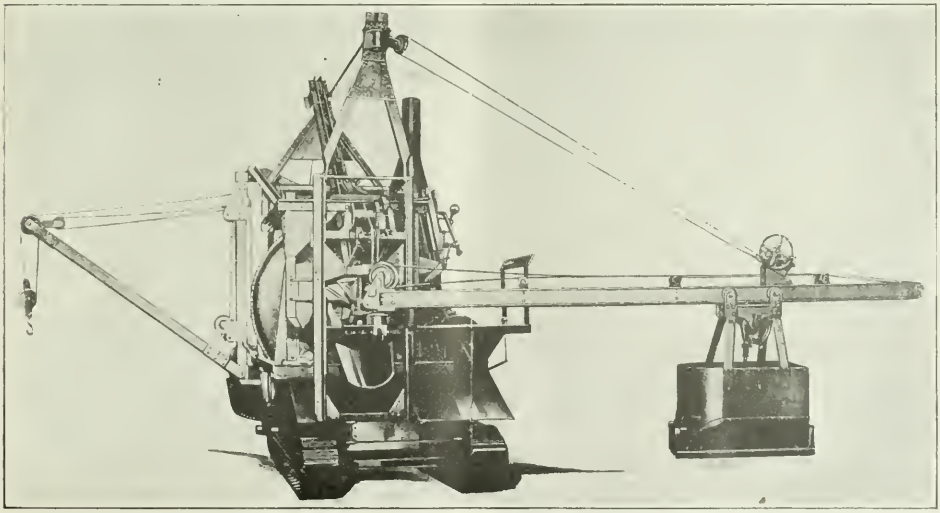


FIG 5—THE COMPLETE PAVER, WITH DERRICK FOR HOISTING BATCH BOXES TO THE CHARGING SKIP

Metering Water in Chicago

Metering caused more than eighty per cent reduction in domestic consumption and seventy-five per cent in total consumption.

The following paragraphs are found in the latest annual report of H. L. Lucas, superintendent of the Water Pipe Extension Division of the Chicago Department of Public Works:

During 1920 meters were installed on every service, about 850 in number, in the town of Hegewisch, with remarkable results in regard to reduction in consumption. A series of curves is attached to this report showing the effect of meter installation. A test made on Jan. 31, 1920 showed the total average consumption in Hegewisch amounting to 2,730,000 g. p. d. On Nov. 10, 1920, when the meters were about one-half installed, the total average consumption was 1,640,000 g. p. d. During 1921 these meters were read on different occasions and efforts made to stop the waste and reduce the loss due to leaky plumbing and the use of hopper closets, resulting in further reduction in this section. Final test made on Oct. 20, 1921 indicated an average daily consumption of 620,000 g. p. d., which is less than 25 per cent. of the original consumption. Following is an interesting comparison between the flows before and after the installation of meters.

	Jan. 1920	Oct. 1921
Total flow, g. p. d.	2,730,000	620,000
Industrial and Burnham, g. p. d.	130,000	160,000
Domestic, g. p. d.	2,600,000	460,000
Domestic, g. p. d., per capita	433	75

The difference in domestic consumption per capita, between 433 gallons in January, 1920, and 75 gallons in October, 1921, is entirely due to the installation of meters. Meter readings indicate that 530 services, more than 60 per cent. of the total, are using less than 23 gallons per capita per day.

Careful leakage tests were made on 78.55 miles of pipe in streets which were about to be paved. These tests were preceded by an inspection of the service pipes and a recommendation by inspectors for cutting off and abandoning unused pipes.

After test and inspection by the engineering party, orders were prepared for work to be done in order to put the mains and appurtenances in good operating condition. The measured leakage on these streets amounted to 1,124,100 g. p. d., of which 1,068,811 g. p. d were stopped. The importance of this work is very great as it meant that the mains in streets which are paved are in first class condition and that the leakage is eliminated. A table attached which shows the results of these tests over a period of the last five years indicates that the leakage in the mains and services is small, approximately 5 per cent. of the total water pumped.

During 1921, 1,043 new meters were installed in the city of Chicago. Of this number 70 replaced smaller services. The total number of meters in service December 31, 1921, was 30,757.

With an average monthly force of 46.9 employes in office, shop and field there were performed 36,749 jobs of repairs, replacements and installations of water meters at a cost of $18,882.59 for supervision and clerk hire; $86,350.36 for mechanics and laborers and $20,503.23 for cartage—a total of $125,736.18 and $55,362.40 for meters, meter parts and material.

The average cost per job of each of the several items was as follows:

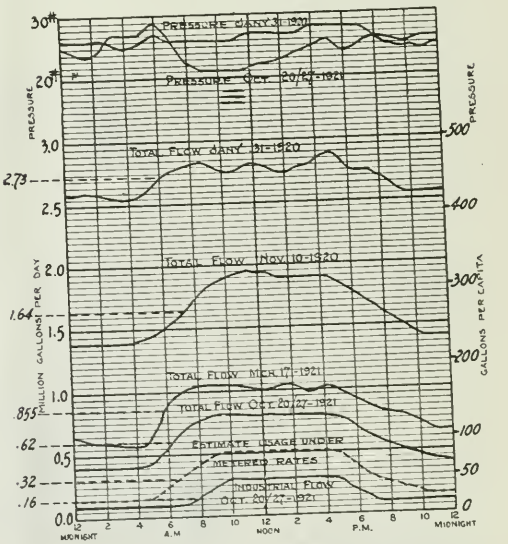
Field work—Investigations, $1.91; meters removed permanently, $2.40; meters repaired on premises, $2.42; meter locations changed, $3.31; meters replaced, $4.92; leaks repaired, $9.21.

Shop work—Meters tested before repairs, $0.65; meters tested and sealed after repairs, $0.53; meters repaired in shop, $5.77; meter parts rehabilitated, $.76; material rehabilitated, $2.58.

The above does not include supervision, clerk hire or maintenance of equipment, which averaged $.90 per item.

Pavement Cuts in Los Angeles

In Los Angeles a special force under the city engineer repairs all trenches cut in streets and charges the firm or person to whom the permit for the cut



CONSUMPTION IN AREA BETWEEN 127TH AND 138TH STREETS, AVENUE A AND YATES AVENUE. 18 acres in parks, 127 in factories, 67 in railroads; 833, total.

was issued at the rate of 40c per square foot for asphalt pavement or brick pavement, 30c per square foot for macadam, concrete pavement or granite block, 12c for oiled gravel and 1c for streets neither oiled, gravelled nor paved; also 28c per square foot for sidewalks and 50c per lineal foot for curb.

Water Works Engineer Honored

A storage dam in the Scioto River forming a part of the water works of Columbus, Ohio, has heretofore been known officially as the "Columbus Storage Dam," this name having been given it by council in 1905. On the 18th of last December council ordered the name of this dam changed to "The Julian Griggs Dam, in honor of Julian Griggs, who so faithfully and well served the city as chief engineer and who was one of the prime movers in the movement to construct said dam and who had general supervision of its construction."

It is not often that a city gives any recognition other than his more or less inadequate salary to the services of an engineer, no matter how profitable these may have been to the city, and this recognition of Mr. Griggs' service is very gratifying.

Philadelphia's Water Finances

The Chief of the Bureau of Water of Philadelphia, Carleton E. Davis, in his report for the year 1922, states that this was the most profitable in the history of the Bureau, the net revenue for the year being nearly $3,000,000. The total receipts were in excess of $6,450,000, which is one-quarter of a million greater than those for 1921. The gross yearly return from the works was more than ten per cent. of the city's entire income from all sources. Deducting the operating and maintenance expenses from the gross income leaves more than enough to carry the fixed charges on more than $40,000,000 of bonds, which is greater than the amount outstanding. Because of this the Court has permitted the exemption of the waterworks bonds from the calculation of the debt limit of the city.

In addition to this direct profit, the city also receives the free use of water furnished to every municipal activity, such as schools, swimming pools, fire protection, etc.; also 90 per cent. of the regular rates is deducted from bills to all charitable institutions, this discount amounting to nearly $150,000 a year.

Low Salaries for Public Officials

An unusual recognition of the fact that many of the technical employees of city, state and federal governments are underpaid is reported from New Jersey, where the State Board of Health in December adopted resolutions favoring the enactment of legislation which would provide a monthly pension for the widow of Dr. R. B. FitzRandolph, who had been assistant director of the State Board of Health for many years prior to his death. It was argued in favor of this that Dr. FitzRandolph had made financial sacrifices in remaining in state employ and that the remuneration paid him had been inadequate for the services rendered.

Municipal Gas Plants

The Census Bureau has recently published a report on "Manufactured Gas," the data being those collected in the year 1920 and applying to the year 1919. Comparison is made with similar figures for the year 1914, showing the changes in the gas industry during that comparatively short period.

These figures show that during this five-year period the number of establishments engaged in the commercial manufacture of gas delivered through mains decreased from 1,284 to 1,082 and the wage earners from 43,792 to 42,908. The product, however, increased in value from $220,238,000 in 1914 to $329,279,000 in 1919. In spite of the slight reduction in number of wage earners, the total wages paid was almost doubled, from $26,802,000 to $52,759,000.

One table was devoted exclusively to municipal establishments and showed that during this five-year period the total number in the United States had decreased from 138 to 57. Most of this decrease was in the east north central and west north central sections. In the New England, Middle Atlantic and Pacific sections the numbers remained the same, while in the South Atlantic section the number of establishments fell from 17 to 15, and in the East South Central from 3 to 2.

Comparing the two years, the number of establishments manufacturing straight coal gas and carbureted water gas remained the same; those manufacturing mixed coal and water gas increased from 3 to 6, while the number manufacturing oil gas decreased from 4 to 2, acetylene gas from 31 to 8 and gasoline (cold process) gas from 71 to 12. The value of the products in these municipal establishments, in spite of the decrease in number, increased from $1,757,017 to $2,778,069. Perhaps the most remarkable comparison is shown by the east north central district, where, although the number of establishments was reduced by about 70%, the value of the products was more than three times as great.

Toledo Garbage Disposal Bids

Toledo recently received bids for disposing of the city's garbage, which at present amounts to between twenty and twenty-three thousand tons per year. Three bids were received, one from the Pan-American Milling Company, which offered to accept the garbage from the city at its West Toledo plant, the city to pay $1.25 per ton and furnish water free to the plant, or $1.50 per ton, the company to pay for the water. The contract to be for ten years. The company proposes to make hog feed of the garbage. (This company last year was receiving about 42 tons a day from the city, which was paying $1.25 per ton and hauling the balance to the country where it was scattered on farms.)

The Indiana Salvage and Feeding Company propose to feed the garbage to hogs, the city to

deliver to a hog farm within a ten-mile radius and pay 75c per ton, or deliver to a farm within a 25-mile radius and pay 50c.

A third bid was submitted by F. C. Alber, who proposed to use the reduction method and turn the by-products over to the city, which would pay him $4.00 per ton of garbage received.

In addition to these three bids, the director of public service, William T. Jackson, has submitted a proposition for constructing four incinerators in different parts of the city, each to handle the garbage from its own district or zone. He believes that this would reduce the cost of collection, which is now more than $1.50 per ton because of the long haul. He estimates the cost of each incinerator plant at about $50,000.

These plans were presented to council early in January.

The costs of collecting and disposing of garbage were reported to have been $82,506 in 1919, $116,918 in 1920 and $141,805 in 1921.

Progress on Decatur Sewage Plant

Work was started late last summer on a sewage treatment plant for Decatur which, it is expected, will be completed early next fall. The sewage will first pass through Imhoff tanks, a dosing tank which will distribute the effluent over about three acres of sprinkling filters, and from these filters the effluent will pass to a Dorr secondary treatment tank 85 feet in diameter. Work on this tank is being carried on during the winter whenever the weather is favorable.

Activated Sludge for Pasadena

Plant to treat six million gallons a day, sludge to be dewatered by sulphur dioxide, drum screen and roller press. Sludge for fertilizer, effluent for irrigation.

For many years sewage treatment at Pasadena was interesting to sewerage engineers because Pasadena conducted one of the few financially successful systems of disposing of sewage by irrigation. The sewage was distributed on a farm of 517 acres and various crops raised, probably the most remunerative being English walnuts.

Recently the growth of population in the vicinity of the farm has caused dissatisfaction with this method of disposal and a substitute was sought for. Last year Pasadena, Alhambra and South Pasadena decided to unite in the construction of an activated sludge plant, this conclusion having been reached after the operation of an experimental plant. One argument in favor of the activated sludge method was the demand for fertilizer in the immediate vicinity.

The plant is designed to treat 6,000,000 gallons a day, although the present sewage flow is little more than half of this. The sewage will first pass through a coarse and then through a fine screen and from this to the aerating tanks of the activated sludge process. Material collected on the coarse screen will be buried and that intercepted by the fine screen will be carried directly to the dewatering plant.

There will be eighteen aerating tanks each 50 feet long, 9 feet wide and holding 15 feet depth of sewage. Each tank will contain 60 filtros plates 12 inches square set in cast iron plate holders previously dipped in hot asphaltum to prevent rust. The plates rest in the holders on felt gaskets and are cemented in place by asphalt poured around the edges, while iron rims bolted to the plate holders by brass bolts will hold the plates in place. Each plate holder will be supplied with air through a 1-inch galvanized pipe. The bottom of the tank is constructed in the form of pyramids between the plates so that no sediment can settle on the bottom and putrefy. It is proposed to supply one cubic foot of air per gallon of sewage and to retain sewage in the aerating tank for four hours.

There will be eighteen sedimentation tanks, each 22 feet long, 9 feet wide on top and holding 27 feet of water in the middle, the bottom being hopper shaped with sides sloping at an angle of 60 degrees, each hopper terminating in a 4-inch discharge pipe. The effluent will discharge over a weir extending the entire length of each side. The effluent from the aeration tanks will enter the sedimentation tanks through adjustable slots three feet below the surface. The sludge pipes from the bottoms of the hoppers rise to within 1 foot of the water surface and there terminate in an elbow, in the outer end of which is an 18-inch nipple, the elbow being loose so that the nipple can be turned into any position from vertically up to vertically down. This construction permits drawing off the sludge at any desired rate up to the full capacity of the 4-inch pipe by simply revolving the elbow.

The sludge is discharged directly into re-aerating tanks 12½ feet long by 7 feet wide and 15 feet depth of liquid, the filtros plates being arranged as in the primary aerating tanks. From the re-aerating tanks any desired quantity of sludge may be returned by means of an air lift to the primary tanks, while decanting devices similar to those in the sedimentation tanks permit the removal at will of sludge to be dewatered.

It is planned to dewater the sludge by the recently developed process of using sulphur dioxide, cylindrical drum screen and roller press, as tested last year at Houston and described in Public Works recently. The sludge with a moisture content reduced to 75% will probably be sun-dried during the summer months and placed on the city farm as fertilizer during the winter. That sun-dried in the summer to about 10% moisture will possibly be passed through pulverizing rolls and sold to orange growers for fertilizer.

The effluent from the sedimentation tanks will be discharge into a ravine or raised by centrifugal pumps for irrigating the municipal farm. That wasted into the ravine will pass over a bluff where a fall of 20 feet over a series of cascades will additionally aerate it.

The air required for aeration will be supplied by electrically driven hydro-turbine blowers capable of

delivering air at a pressure of 10 lbs. At the plant will be constructed a chemical laboratory and an office for the superintendent in one building, a tool house and garage in a second, and the necessary machinery will be housed in a third.

Milwaukee Refuse Destructor Report

Description by City Engineer Staal of incinerator plant at Montevideo and result obtained by it.

Several months ago the city engineer of Milwaukee, George F. Staal, examined a refuse destructor in operation at Montevideo, Uruguay, and has reported upon the same to the Common Council of his city, with a view to aiding it in its study of methods and appliances for refuse disposal suitable for supplementing the refuse destructor plant of Milwaukee which has almost reached the limit of its capacity. The following is abstracted from Mr. Staal's report:

Montevideo has a population of about 400,000. It is distinguished by its superb system of boulevards and parks, surpassed by few if any of North America. It is all the more notable, therefore, that the refuse disposal plant of the city is located only seven blocks from the municipal building and on the new Boulevard Wilson, in a residential district. A committee of prominent engineers and sanitarians of Uruguay in 1914 reported, recommending high temperature incineration for disposing of the refuse of that city and a plant on the Balmer system, several of which were already in operation in Buenos Aires.

The plant comprises three batteries of furnaces, each battery containing three fire grates 6 ft. x 7 ft. under a common crown. The furnace doors are cast in two sections which are air jacketed, hang on rollers and have a free lateral movement in either direction. Each battery has its own forced draft unit consisting of a Sirocco fan blower and a G.E.C. motor of 15 h.p. The supply of air to each ash pit is controlled by a simple slide valve. The ash pit doors fit with a tight gravity seal.

Each battery has three mechanical feed hoppers, the discharge of which to the furnace is controlled by the fireman by means of a hand wheel at the side of the corresponding furnace door. The three batteries are connected by an overhead platform in which the mechanical feed hoppers are set. This platform, called the charging platform, runs the full length of the furnace room and on it work the men who draw the refuse from the storage bins and load it into the mechanical feed hoopers.

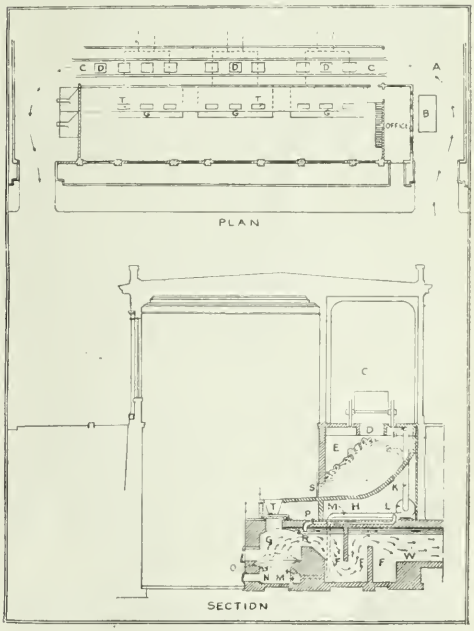
The refuse storage bins run parallel with and above the batteries of furnaces. They are built of reinforced concrete and form part of the structure of the runway or bridge which spans the whole plant and over which the refuse trucks pass on their arrival at the plant. These bins are of ample capacity for receiving a whole day's supply of refuse, with additional space for emergencies.

Two flues connect each battery with a combustion chamber in the rear, which contains two baffle walls which alter the course of the gases and precipitate floating dust. The chimneys are of reinforced concrete with firebrick lining and are 114 feet high.

The entire plant is covered with a building of fine appearance. Hot and cold baths and a large, well-furnished rest-room and laundry are provided for the staff.

The site on which the destructor is placed is central, it adjoins the principal municipal garage, and the topography of the site is such that a ramp is unnecessary, but teams can drive from the street directly on to the charging floor, while ashes and clinker are withdrawn at a lower level, which also is street level. The several movements of the refuse between dumping, storing and burning are all effected by gravity. The only mechanical operations are those of the fan blowers which supply the forced draft, and the feed hoppers which load the refuse into the furnaces.

Garbage, rubbish and ashes are all collected together. Each route in the city has its own peculiarities as to composition of refuse, and each vehicle has its own route. Consequently the operator knows by the number of the vehicle the approximate nature of the refuse that



PLAN AND CROSS SECTION, BALMER REFUSE DESTRUCTOR

it brings to the plant and he therefore can readily determine which bin it is best to dump the truck into. The number of each furnace is exhibited conspicuously on the walls of the runway or dumping floor, and each truck driver on arriving at the destructor is given the number of the furnace to which his load is assigned.

On entering this runway the wheels of the truck are engaged by guide rails of channel iron. Between these rails, in the floor of the bridge, are the trapdoors through which the refuse is discharged into the storage bins. When a truck has passed over the trapdoor to which it is assigned, it stops and the trapdoor is lifted in the direction opposite to that of the truck's movement. As the door is lifted, a bar that is countersunk in its upper surface swings out automatically and holds the door in a position inclined slightly from the vertical. The truck body is then tilted backward and the refuse dumped through the opening, the inclined door acting as a stop to prevent objects from being thrown beyond the opening onto the floor. As soon as the empty truck body is returned to normal position the door is closed and the truck moves on. Two men assisted the truckman in dumping the trucks, raising the doors and kept the bridge floor clean. The amount of refuse delivered daily exceeded 200 tons.

In the storage bins the refuse is heated indirectly from the furnaces below. It is drawn out by rakes into the mechanical feed hoppers, into which it falls by gravity. These hoppers are set directly over the crowns of the furnaces, into which they are discharged by the operator from the floor below, the refuse falling directly on to the fire grate.

Clinker is removed by means of special tools used through the furnace door and is loaded on to specially designed trucks. After the clinker has been removed from a fire grate, a new fire is started by dropping a charge of light material on to the fire grate, when the heat from the other grates under the same crown ignites this charge.

Between the floor of the storage bin and the crown of the combustion chamber, above which it is suspended, there is a closed hot air chamber which is heated by radiation from the combustion chamber. This hot air chamber distributes heat evenly through its roof, which is also the floor of the storage bin, to the refuse in the bin.

The forced blast draws its air from the storage bin by means of pipes and flues and discharges the air through piping and channels to the ash pits and combustion chamber of the battery which it serves. The air so used by the fans, in passing through the storage bin, absorbs the fumes, vapors and gases given off by the heated refuse. This air, therefore, is not only hot but absorbs and carries with it carbohydrates which aid in the combustion of the furnace.

It is claimed that the heating of the refuse in the storage bin is of great advantage, and is in fact the peculiar feature of the Balmer plant. "The garbage, which already arrives in a state of incipient putrefaction, develops there in the course of a few hours after arrival at the plant, a rapid and advanced fermentation which permeates throughout the mass, producing at the expense of the water content a large variety of alcohols and ethers. These carbohydrates, whether remaining in the garbage or passing off as vapor in the air supplied to the furnaces, are a valuable aid to efficient combustion. Under the action of heat, the hydrocarbons are volatilized in part, the vapors either penetrating the rest of the refuse and thus rendering it more combustible, or passing off as vapor with the air supply to the furnaces—contributing, in both cases, to accelerate and intensify combustion. In the course of the day, considerable quantities of water vapor must pass off from the heated mass of refuse, thus relieving the latter of a portion of its greatest handicap to combustion."

Official figures of refuse destroyed give this as containing 93.4 per cent. of household refuse, 2.1 per cent. of street sweepings, 3.1 per cent. of market refuse and 1.4 per cent. of miscellaneous. There is practically no ashes in the refuse. The moisture content is stated to average 55 per cent.

Special investigations were made by Mr. Staal with the consent of the city engineer of Montevideo. From these he found that the temperatures in the furnace and combustion chamber did not at any time fall below 600 degrees C. or 1112 degrees F. The CO_2 varied from about 7% to 14½%, averaging between 10 and 11.

The interval between two consecutive charges averaged nine minutes. Clinkering was done once every six hours, which was the length of shift of the workmen. In clinkering, the clinkers were drawn directly into small special carts which transport them outside where they are dumped as fill on the low land adjoining. The ashes are first dropped on to the floor and then shovelled into carts. It was suggested that mechanical contrivances would be advantageous in order to save labor in this work.

The three furnaces have a nominal capacity of 270 tons of refuse per day, and it is claimed could burn 300, although an average of 210 to 220 tons were being burned last year.

The municipal officials have for some time been promising a five-year report on the operation of the destructor, but this Mr. Staal was not able to obtain. The only official figures available were those for the year 1916, the first year of operation. During this year the furnace consumed 71,383 cart-loads of refuse weighing 151,763,392 pounds. In addition to the regular refuse, there were destroyed 2,980 dogs, 45 sheep and 26 other animals. The amount of refuse did not vary much from month to month, the minimum per month being 11,781,275 pounds and the maximum 15,211,792 pounds; in only one month, however, did the amount exceed 13,000,000 pounds. It is said that there is at no time any odor or other nuisance about the plant and that the vapors from the chimney are scarcely visible at any time.

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Variations in Pavement Reinforcement

A wide variation in practice among the cities of the country is found in the weight of pavement reinforcement used. The number using reinforcement has increased greatly during the past two years, but nothing approaching standard weights has been adopted. Weights of fabric as low as 25 pounds per hundred square feet are found, and 30 pounds is common; while as high as about 85 pounds is used, and bars range from 20 to 100 pounds. Figures are given in two articles in this issue.

Of course, different traffic weights would require different strengths of pavement to meet them, but we wonder to what extent the variations in weight are based upon scientific calculations. As a matter of fact there does not yet seem to have been developed a theory for calculating reinforcement based upon any generally accepted assumptions or experimental results. The test road at Pittsburg, Cal., was expected to aid in developing such a theory, but, so far as we know, practically no conclusions have been made public that advance appreciably our knowledge of the subject. In view of the millions of dollars being spent on reinforced pavements a thorough scientific investigation of the subject is urgently needed.

Immigration and Wages

Although labor may not be a commodity, and although minimum wages may be fixed by law, the law of supply and demand will in the end prevail, we feel assured. If wages be kept too high artificially, additional substitutes for labor will be found in mechanical appliances to offset this. If the supply is kept inadequate by immigration laws wages will advance, following the law of supply and demand, and the same result — increase in labor-saving appliances—will follow. This is not prophesy; it is history of the past six years. Compare the wage rate curve for that period with the areas occupied by the road shows during the same years, allowing for one or two years' lag for the development of the machinery after the demand is realized.

During the year from July 1, 1921, to June 30, 1922, according to the U. S. Bureau of Immigration, 40,319 Italian immigrants entered this country and 53,651 left; 3,457 Greeks entered and 7,506 left; 28,635 Poles entered and 33,581 left. A large part of our unskilled labor is supplied by these countries. Result: Unskilled labor wage rates on February 1 are 90 per cent above pre-war level, while cost of living is about 56 per cent higher; and wages have risen 15 per cent during the past year.

Water Meters and Consumption

One of the most startling results of metering that has come to our notice is reported from Chicago. An extract from the report of the Department of Public Works of that city, published on another page of this issue, shows a reduction of more than eighty per cent in per capita consumption within a few months after beginning a general introduction of meters in one of the districts of the city. The report states that this "is entirely due to the installation of meters."

Engineers in Public Service and Private Practice

Many of the engineers in the various departments of public service are habitually engaging in private engineering work, and a feeling has been growing among engineers in private practice that this is unfair and unethical. It has, in fact, developed to the point where the American Association of Engineers has thought it necessary to take official notice of the condition and appoint a committee to look into the matter. This committee, of which Wm. Artingstall of Chicago is chairman, has sent a questionnaire to about 400 engineers in public service and others in private practice, asking the former for facts as to their employment and both for opinions as to whether the former should be prohibited from such competition.

Among the questions asked of private practitioners are whether private work of the "Public Engineer" should be prohibited, or restricted, or limited to consultation for other public bodies, or to straight consultation (without any office force); and whether his salary permits his giving up private practice.

The engineers in public service are asked their opinions on practically the same points, and also whether part or all of fees received should be turned over to the public departments from which they receive their salaries. The public engineers addressed include those employed by cities, counties, states, highway departments, etc., and they are asked in addition to tell (under pledge of secrecy) their salaries, whether they are expected to perform other public work aside from their regular duties and whether they receive additional compensation therefor, whether they engage in private practice with or without a private office or organization, and whether they must obtain permission for this; also whether there are any local regulations, laws or customs covering these points, and whether the one answering considers his official salary "commensurate with the duties required," and whether he would abandon private practice if the salary were adequate.

The returns from this questionnaire will at least be of interest, and will possibly furnish the argument for an effort by the society to secure legislation on the subject by city, county and state governments.

Engineering Employment for 1923

The Employment Department of the American Association of Engineers, in its review of the year 1922, reported that employment for engineers improved steadily throughout the year, except for the customary dullness due to the usual year-end pause in engineering work.

It reports that there is every indication of a shortage of technical men during the early part of 1923. There is much demand for designers. It anticipates especially a demand for specialists on construction, particularly on buildings and hydro-electric and drainage projects; also a fair demand in the highway field. Little demand is anticipated for railroad engineers, and the same is true of the electrical field.

Salaries increased from ten to twenty per cent during 1922, although in some cases they were reduced. Last year graduates in engineering received an average of $125 per month.

Tennessee State Highway Department Reorganization

Under a re-organization bill recently introduced and passed by both houses of the Tennessee Legislature, the State Highway Department is to be known as Department of Public Roads and Buildings, to be headed by a commissioner and its chief engineer. This bill came into effect February 1, abolishing the old order of having three commissioners, representatives of the three divisions of the State and of both political factions. Under the present law one commissioner, appointed by the Governor, will head the organization, receiving remuneration of $5,000 per year, and holding the title of Commissioner of Engineering. The chief engineer's salary remains $6,000 annually, the same as under the old law. J. G. Creveling, Jr., county highway engineer of Davidson County, has been appointed by Governor Peay for this position, taking office February 1.

It is possible that legislation affecting highway revenues will be enacted during the present Legislature. Governor Peay in his inaugural message recommended a tax on gasoline sales of two cents per gallon and removing the present highway levy on general taxation.

New State Highway Commission for New Jersey

One of the first acts of Governor Silzer of New Jersey, early this year, was to remove the State Highway Commission of seven and recommend a commission of three men. The State Legislature on February 13 passed a bill providing for a bi-partisan commission of four which, although he did not approve of (because of the disadvantages of bi-partisan boards, including probability of a deadlock, proved by past history) he at once signed and sent to the Legislature nominations to the board as follows: General Hugh L. Scott, Percy Hamilton Stewart, Walter Kidde and Abraham Jelin. The nominations will be considered for confirmation on February 19. Each member receives $7,500 a year. The commission will appoint a State highway engineer to succeed Thomas J. Wasser.

Bills are pending in the State Senate providing for open specifications in building State highways.

North Carolina's Road Law

Early in February the State Legislature of North Carolina passed a bill providing for a $15,000,000 bond issue to continue the highway construction program begun with the $50,000,000 authorized in 1921. The bill also raises the tax on motor fuel oil from one cent to three cents per gallon.

Trenton Sewage Disposal

Comparison of various systems of treatment by Geo. A. Johnson results in recommendation of the direct oxidation process. Figures from the test of the Allentown plant.

The report of George A. Johnson on Sewage Disposal for the city of Trenton, New Jersey, has just been made public. It is a very complete discussion of the subject, giving in full detail the data secured by the investigations as well as his conclusions and recommendations.

Sometime before the war the State Department of Health of New Jersey directed the city of Trenton to build a sewage disposal plant and plans were prepared by Hering and Gregory in 1911 and approved by the department, but no further steps had been taken when the war stopped all work of this kind. In April, 1921, the State Department of Health refused to permit the city to make any more sewer extensions until the matter of sewage treatment had been attended to and in March, 1922, the Court of Chancery issued a mandatory injunction directing the city to adopt plans approved by the department within six months and to stop emptying raw sewage into the Delaware river within eighteen months. As a result of this, the city on June 23rd employed Mr. Johnson to investigate the subject and make a report not later than September 23rd. The report was made recommending the construction of a "direct oxidation" plant, was accepted and Mr. Johnson was directed to prepare detail plans; which plans have been presented to the State Department of Health and its engineer has recommended that a permit for construction of the plant be given.

The report gives in detail figures of past population and anticipated population, records of temperature, of sewage flow, of river flow, etc. The sewage flow was obtained at first by automatically recording the height of sewage in a manhole near the outlet of the main sewer, the height being determined by a float in a stilling box; subsequent to which the flow was measured by a current meter.

The city is sewered on the combined plan over about 20% of its area and the separate plan over the remaining 80%. In making the estimates, a plant capacity was provided to allow for 5,000,000 gallons of storm water in addition to the dry weather flow before the storm water would overflow through outlets into the river; this being about 20% of the estimated dry weather flow in 1923, or 9% of that in 1950.

"The sewage of Trenton requires treatment that the waters of the Delaware river may be constantly maintained in attractive and inoffensive condition; and that the health and well-being of the population resident in communities and scattered along its banks below Trenton may be properly conserved. Prior removal of the grosser solid matters, and the more complete dispersion of the partially clarified sewage through the flowing body of water in the river, might keep the river water attractive and odorless for most of the time, but such procedure would not satisfy the State Department of Health nor fulfil the obvious duty of the City of Trenton to its neighbors downstream."

The city had purchased before the war 60 acres of land on the river front and just below the main sewer outlet, which Mr. Johnson found to be the best obtainable for a sewage treatment plant. However, it is so situated as to surroundings that it will be necessary to minimize nuisance. The main outlet is necessarily so low that pumping will be required wherever the treatment plan be located or whatever its nature.

In his discussion of the treatment plan to be adopted, Mr. Johnson described the various processes in common use, and stated that all of these excepting activated sludge and the direct oxidation process "periodically fail to give results consistent with the desires and intent of the designers and operators. . . They also show reduced efficiencies in cold weather, and are very liable to yield unsatisfactory effluents, at least for short periods, at other times. And they all, without exception, create a nuisance in the neighborhood wherein they are located." The unreliability he attributes chiefly to the fact that they are dependent upon "the capricious activities of various forms of bacterial life."

Of all the recognized methods of sewage treatment but three are worthy of serious consideration in connection with the Trenton problem. One of these, the Imhoff tank-sprinkling filter system is barred from consideration because it is a local nuisance breeder, hence its utilization would invite trouble from nearby property owners. Furthermore, its first cost would be prohibitively high.

The Activated Sludge process is suitable for the treatment of the sewage of Trenton, but it produces larger volumes of sludge than any other type of sewage treatment, and this sludge is not only difficult and expensive to de-water and handle, but is putrescible to a far greater degree than the sludge of other practical processes of sewage treatment. It is a difficult process to manage so as to secure uniformly satisfactory results, but does produce, and with little or no nuisance, a very high-grade effluent. The sludge problem, however, remains unsolved at this date.

The Direct Oxidation process is just now receiving the recognition it deserves. You now have before you in Chapter XI the results of my tests on this system, made at Allentown last July and August. Furthermore, the result of the investigation of the Phillipsburg installation, recently made by the State Department of Health of New Jersey, have just been made available to you.

With the adoption of the Direct Oxidation process the following chief advantages will be gained:

1. A definite and permanent purification of the sewage of the City of Trenton to a degree where no valid objection to the discharge of the effluent into the Delaware river can ever be made by any of the riparian owners below.

2. Positive and permanently inoffensive disposal of the sludge produced, first, by constructing dykes about the plant and filling ground, and, later, disposition of the sludge for agricultural purposes.

3. An installation attractive to the eye in every department and bearing no resemblance whatever to a sewage treatment plant, such as the public commonly visualize in works of this character.

4. Complete freedom from odors and flies anywhere about the plant.

5. Lowest first cost of construction and at least equally low total cost of treatment as compared with other methods of sewage treatment which are less easily managed, less reliable, and which are certain nuisance breeders in some particular and in variable degree.

Specifically stated, the comparative cost of sewage treatment at Trenton by the only three processes deserving of serious consideration in these premises is as follows:

Comparative Cost of Sewage Treatment

based on the treatment of an average daily sewage flow of 30,000,000 gallons. Plants are complete in all departments and include everything from the connections with existing outfall sewer to the new effluent discharge line into the Delaware River.

	Imhoff Tanks and Sprinkling Filters	Activated Sludge Process	Direct Oxidation Process
Total first cost	$2,988,000	$1,475,000	$1,063,000
	Per Annum		
Capital charges at 7 per cent	148,725	100,625	70,315
Labor, power, maintenance and supplies	86,450	116,250	125,000
Total Annual Cost	$216,175	$225,875	$195,315

In this comparison of the sludges produced by the various methods he gives the following figures: Plain sedimentation 4.5 cubic yards per million gallons with 95% moisture; septic tank, 4.0 cubic yards with 85% moisture, Imhoff tanks, 3.0 cubic yards with 85% moisture, activated sludge 5.0 cubic yards with 95% moisture; chemical precipitation 2.5 cubic yards with 88% moisture; and direct oxidation 2.5 cubic yards with 94% moisture. Activated sludge is by far the largest in amount and putrifies rapidly, while experience has shown that that from the direct oxidation process remains stable indefinitely.

The plant is located on low land which is flooded during high water and it is desirable to surround it with a levee and sludge which remains stable can be used to advantage in constructing this, the plant meantime being protected by embankments of sheeting and in contact with the several structures.

Whatever type of plant be employed it would be necessary to employ coarse screens, grit chambers, fine screens and a pumping plant. For completing the treatment, Mr. Johnson considered Imhoff tanks with sprinkling filters, activated sludge and direct oxidation. With the Imhoff tanks, sludge beds would be provided. With the activated sludge plant, thickeners would be used and hand drying and the same for direct oxidation. He estimated the cost of the screens, grit chambers, pumping plant, and necessary sewer connection and outlet, at $400,000. An Imhoff and sprinkling filter plant at $1,583,000; an activated sludge plant at $1,075,000 and a direct oxidation plant at $963,000.

On the basis of the cost figures shown there and believing that the direct oxidation process produces a more stable sludge and can be operated without creating any nuisance, he recommended this for Trenton. In connection with the discussion of this he referred at length to the test made last year at the Allentown plant. In making this test the plant was operated not only in the normal way, but also using electricity alone without lime, using lime alone without electricity, and applying 2/3 of the lime ahead of the electrolyzer, and a fifth plan of applying 1/3 of the lime ahead of the electrolyzer. The average amount of lime used under the normal method of operation was 1,500 pounds per million gallons, when operating with lime alone the amount averaged 1525 pounds; when 2/3 was applied ahead of the electrolyzer the amount averaged 2070 pounds and when 1/3 was applied it averaged 1706. The last two methods used are known as split flow D & E respectively. The accompanying table shows the average percentages of removal by the five methods of operation.

Average Percentage Removal of Principal Constituents of Allentown Sewage by Different Methods of Operation.

Constituents	Elec. Only	Lime Only	Normal Dose (D)	Split Dose (E)	Normal Split Dose (E)
Suspended matter					
Total	37.0	10.0	45.2	20.6	12.1
Volatile	58.3	10.6	54.0	25.0	4.0
Organic carbon	0.7	29.0	45.3	40.0	40.
Organic nitrogen					
Total	14.5	17.5	44.7	45.7	31.3
Dissolved	8.3	34.4	34.0	27.6	52.6
Free ammonia	0	37.5	40.0	29.0	32.0
Total bacteria	87.0	94.6	99.0	98.0	94.0
B. Coli	0	95.6	99.00	97.0	93.0

[illegible]

Commenting briefly on the above results it is to be stated that the sewage, coming from the average was found in the laboratory tests and when the electrolyzers were operating at full capacity the results were as satisfactory as when the rate of treatment was considerably lower. The results therefore recorded therefore may safely be taken as equally representative of the efficiency of the process under full [illegible]

(Continued on page 711)

Replacing Trenches in Streets

Requirements of cities concerning cuts made in city streets and the backfilling and repaving of them.

A large number of cities have filled out our questionnaire concerning their procedure in connection with the opening of streets by private individuals or corporations for the purpose of laying pipes, making repairs, etc. and, especially, the replacing of the excavated material and pavement. At the time of making this summary 440 cities have reported, although more are coming in daily and will be added to the tabulation. These 440, however, are found in all but four of the states of the Union and it is believed that they represent the general practice of the country.

We find that of these 440 cities, by far the largest number require the backfilling of the trenches to be done by the plumbers, contractors or others acting for private parties who made the street opening. However, 72 cities perform their own backfilling with their own employees, 10 additional ones do so wherever the street is paved, 9 do so except where the cut was made by a public utility company, and 7 others do the backfilling in some cases (conditions not stated) and allow private parties to do so in others.

In replacing the pavement, however, we find an unexpectedly large number of cities performing this work themselves. Of the 440, 276 report that all pavements are replaced by the city, either by their own forces or, in a few cases, by paving contractors under contract with the city. In 5 cities the public utilities only are permitted to repave over cuts made by them, presumably because they have men in their employ experienced in this work. Four of the cities replace with their own forces a certain kind or kinds of pave-

ment, allowing other kinds to be replaced by private individuals; while in 11 other cases the city sometimes does this work itself and sometimes permits others to do it under conditions not stated.

Five cities make no charge for the work done in replacing the pavement, but all the others make charges by various systems. Fifty-eight cities have regular schedules, most of them regulating the charge by the kind of pavement replaced as well as by the area. The great majority, however, charge the actual full cost of performing the job in question, including both labor and materials. The cost alone is charged by 171 cities, but a number of others charge the cost plus a certain percentage, this percentage being 5 per cent. in three cases, 10 per cent in sixteen cases, 12 per cent. in one case, 15 per cent. in one case, 20 per cent. in five cases and 25 per cent. in one case, while two charge the cost plus $5.00 and one the cost plus $2.00.

Where the backfilling is done by the parties by whom the opening in the street is made, an undesirably large number report no regulation of the manner in which the backfilling is done. It is probable, however, that in some cases where this report was made, the city engineer or other official can require the work to be done to his satisfaction, forty-four cities reporting that the filling must be done to the satisfaction of the city engineer, street superintendent or some other city official. Seven have as the chief requirement that all the dirt that was excavated shall be put back into the trench. Eighteen require that the street be returned to a condition equal to that in which it was found. Most engineers will recognize that this is impracticable in the majority of cases, and two cities recognize this by requiring that it be returned to as nearly as possible the original condition. It is interesting to learn that fifteen cities require that, where the streets are paved, the material excavated be removed and the trench be filled with sand or gravel, this sand or gravel being thoroughly compacted either by ramming or, in a number of cities, by saturating with water.

The majority of cities, however, have regulations for the compacting of the backfilling, some as parts of the ordinance and some as regulations of the department of public works, city engineer, etc. Quite a number require tamping in layers of specified thickness, this varying from a minimum of four inches to a maximum of twelve inches, six inches being the most common thickness specified. Quite a number require that on paved streets the pavement itself be cut back a distance from the side of the trench varying from six inches to a foot in the different cities, thus affording a shoulder of solid earth to support the new concrete base, which concrete base in some cities is reinforced and in a few is made thicker than the base under the rest of the pavement.

As a whole, the reports show that a very gratifying amount of attention has been paid to this important subject by the various cities, while several state that the problem is receiving attention and improvements in the regulations are under consideration.

Concrete Pavement Reinforcement

Kind and weight of reinforcement used by each of one hundred cities in constructing concrete pavements.

The following information concerning the use of reinforcement in concrete pavements has been furnished to us by the several cities named. This information in general applies to the concrete pavement which is to be laid during 1923. Unless otherwise stated the weights are per hundred square feet.

Fort Collins, Col., will use 4-inch by 8-inch mesh. New Britain, Conn., will use 34-lb. fabric. Americus, Ga., has been using 4.7-lb. fabric per square yard.

Benton, Ill., will use 33 to 36-lbs. Canton, Ill., will use fabrics of standard weight. East Moline, Ill., uses National Steel Fabric Company 43.6-lbs. Edwardsville, Ill., uses 32-lb. fabric on some work and 62-lb. on other. LaGrange, Ill., uses 40-lb. fabric. Mattoon, Ill., 40-lb mesh. Monmouth, Ill., 51-lb. fabric. Naperville, Ill., 36-lb. fabric. Ottawa, Ill., 36-lb. wire mesh. Pana, Ill., 40-lb. fabric. Riverside, Ill., American Steel Wire Company 35-lb. mesh. Waukegan, Ill., 35-lb. fabric.

Boonville, Ind., 30-lb. Fort Wayne, Ind., 40-lb. Gary, Ind., 34-lb. fabric. Huntington, Ind., 40-lb. fabric. Winchester, Ind., fabric and bars, about 50 lbs.

Clinton, Ia., ½-inch square bars spaced 6 feet each way. Decorah, Ia., 30 to 40-lb. bars now used, mesh used previously. Ottumwa, Ia., ⅜-inch bars, 75 lbs.

Corbin, Ky., 35-lb. fabric. Lexington, Ky., 40-lb. fabric. Paducah, Ky., ¾-inch round bars 30 inches from the edge and from the center line. Bangor, Me., ½-inch deformed bars 85 lbs.

Brockton, Mass., bars 94 lbs. Greenfield, Mass., bars 80 lbs. Pittsfield, Mass., bars 27 lbs. Worcester, Mass., bars 75 lbs.

Grand Rapids, Mich., 25-lb. fabric. Pontiac, Mich., 65-lb. fabric. Duluth, Minn., 32-lb. mesh. Mankato, Minn., 40 lbs. South St. Paul, Minn., 60-lb. fabric in 10-inch concrete pavement. Brookfield, Mo., 40-lb. fabric. Hannibal, Mo., 45-lb. fabric for 30-foot width or over, 25-lb. for less width. St. Louis, Mo., 40 lbs. Butte, Mont., bars 51 lbs. Fremont, Neb., 32-lb. fabric.

Cape May, N. J., 40-lb. fabric. Millville, N. J., 58-lb. fabric. Phillipsburg, N. J., 65-lb. fabric.

Amsterdam, N. Y., 28-lb. fabric. Cohoes, N. Y., 40-lb. Gloversville, N. Y., bars 50 to 85-lb., depending on subsoil. Herkimer, N. Y., 71 lbs. Lackawanna, N. Y., will use bars, weight not determined. Little Falls, N. Y., two layers of fabric each 40 lbs. Lockport, N. Y., mesh 41 lbs., bars 83 lbs. Massena, N. Y., 65 lbs. mesh. Olean, N. Y., 75 lbs. Schenectady, N. Y., 60-lb. to 100-lb. bars. Greensboro, N. C., fabric. Fargo, N. D., 40-lb. fabric.

Grand Forks, N. D., ½-inch round bars along edges of blocks and 30-lb. fabric for 20-foot pavement and 40-lb. fabric for over 20 feet. Wahpeton. N. D., ½-inch transverse bars spaced 18 inches centers.

Bellaire, O., 56-lb. fabric. Bucyrus, O., 56-lb. fabric. Cincinnati, O., 28-lb. fabric. Dayton, O., 28-lb. fabric. East Youngstown, O., 56-lb. fabric. Ironton, O., 28-lb. fabric. Marion, O., 50-lb. fabric. Ravenna, O., 34-lb. fabric. Struthers, O., 56-lb. fabric. Wooster, O., 56-lb. fabric. Muskogee, Okla., bars along edges and slab dowels.

Allentown, Pa., 54-lb. mesh and 25-lb. mesh. Bangor, Pa., 56-lb. fabric, bars at all joints. Blairsville, Pa., 28-lb. fabric. Catasauqua, Pa., 27-lb. fabric. Clairton, Pa., 65-lb. fabric. College Hill, Pa., 32-lb. fabric. Easton, Pa., 56-lb. fabric. Hazleton, Pa., 50-lb. fabric. Lebanon, Pa., 33-lb. fabric. Monongahela, Pa., 56-lb. Munhall, Pa., 48-lb. Sayre, Pa., 65-lb. Tyrone, Pa., 65-lb. fabric.

San Benito, Tex., 20-lb. bars. Salt Lake, Utah, 45 to 50-lb. fabric. Barre, Vt., 30-lb. fabric. Bennington, Vt., fabric. Rutland, Vt., 22½-lb. bars. Clarksburg, W. Va., 56-lb. fabric. Manitowoc, Wis., 33 and 48-lb. fabric. Ripon, Wis., 55-lb. Stevens Point, Wis., 28-lb. fabric. Wisconsin Rapids, Wis., 40-lb fabric. Casper, Wyo., 28-lb. fabric.

Bonds and Deposits for Trenching Permits

Practices of the various cities in requiring guarantees that trenches and pavements excavated by private parties will be properly replaced and maintained.

Most and possibly all cities and boroughs require that a contractor, plumber or other party wishing to dig a trench or make any other opening in a street surface shall obtain a permit for doing so from the proper authorities. Ordinarily there is a charge of from $1.00 to $5.00 per permit. In addition to this, some cities require that a bond or deposit be furnished to cover any cost to which the city may be put in replacing the pavement, where such replacing is done by city forces; or to insure that the parties opening the trench will conform to the ordinances and regulations of the municipal department having jurisdiction. Reports on this subject have been made to us by a number of cities, which reports are assembled briefly in the following paragraph:

New Britain, Connecticut, requires the contractor to furnish bond. Waukegan, Illinois, requires the contractor to deposit with the city the amount which the city engineer estimates will cover the cost to the city of replacing the trench and the pavement. In Marion, Indiana, contractors and plumbers who do work of this kind are placed under a bond which we presume is supposed to be adequate to cover all the work that they may do. Richmond, Indiana, requires a deposit to be made before a permit is granted sufficient to cover cost to city of backfilling and paving plus 12 per cent. In Shelbyville, Indiana, the contractor gives a bond to replace the street in first-class condition, and this is the practice in Winchester, Indiana, also. In Creston, Iowa, the contractor deposits the estimated cost of backfilling and repaving by the city before the permit is issued, and this is the practice in Waterloo, Iowa, also. In Independence, Kansas, the contractor is required to give bond to keep the restored excavations in repair. In Salina, Kansas, contractor gives cash bond to refill trenches and replace pavement satisfactory to the city engineer. Corbin, Kentucky, requires a bond, and Paducah, Kentucky, a bond or a cash deposit to assure his reimbursing the city for cost of backfilling and repaving trench, and in addition requires an indemnity bond to protect the city against lawsuits or accidents. Faribault, Minnesota, requires a bond conditional on replacing the street in its original condition, which the engineer reports is difficult to enforce and does not secure satisfactory work. Contractor's bond is required by Mankato, Minnesota, and Brookfield and Excelsior Springs, Missouri, to replace the pavement in good condition. In Billings, Montana, a surety bond is required. In Laconia, New Hampshire, a deposit is required. In Camden, New Jersey, a deposit is required of $10 on old 6-inch asphalt streets and $20 on new 8-inch asphalt streets, in addition to which the plumber is under an annual bond of $500; moreover, the department refuses new permits to plumbers flagrantly derelict. In Freehold, New Jersey, a $10 deposit is required. In Roselle Park, New Jersey, the cost of laying new pavement is collected when the permit is issued. In Amsterdam, New York, a deposit or bond is required, amount of deposit returned being based on cost of replacing pavement and condition of trench after six months. Lockport, New York, requires a bond to be filed. In Manhattan Borough, New York, public service corporations restore the pavements, but a deposit equal to the estimated cost of restoring pavement is held for six months and used to repair any settlement during that time. In Elyria, Ohio, a deposit must be made when permit is granted covering cost to city of repaving plus 15 per cent. Lakewood, Ohio, requires deposit in advance to cover cost to city of repaving. Lancaster, Ohio, requires cash deposit of $10, held for six months. In Wooster, Ohio, the contractor refills and repaves, but makes deposit to guarantee proper work. In Butler, Pennsylvania, a bond is required of $2 per foot of trench. In Chambersburg, Pennsylvania, a deposit is required and the cost of repaving by borough deducted from it. In Clairton, Pennsylvania, bond or deposit is required. In Greensburg, Pennsylvania, a $50 deposit is required. In Cranston, Rhode Island, contractor must pay city, on obtaining permit, stated amount for replacing pavement. Dallas, Texas, and Bluefield, West Virginia, require deposit to cover cost to city of replacing pavement. Tomahawk, Wisconsin, requires bond to cover returning trench to "original condition."

Municipal Paving in Massena

Village did thirty-eight thousand dollars of force account paving for about a thousand dollars below the low bid, using municipal plant costing about four thousand dollars and hiring teams and some equipment.

During the summer of 1922 the village of Massena, N. Y., paved three streets totaling 4,408 feet in length, together with side curb, with municipally hired labor and municipal apparatus, the following information concerning which has been furnished by W. E. Timmerman, village engineer:

Before the village decided to do this work itself, it advertised for bids, but after receiving bids decided to do the work itself. Work was started on July 12th and completed Oct. 17th. The work would have been completed about Sept. 30th had not the last shipment of cement been delayed nearly two weeks by conditions of freight traffic. One of the advantages of local construction was that 60 per cent. of the materials and supplies were purchased through local dealers and 75 per cent. of the labor cost was distributed among men residing in the village.

The work to be done included grading, in connection with which several hundred yards of old macadam were removed and gravel placed on dirt streets that needed repairs. The paving was all concrete, mixed 1:1½:3. The concrete for curb was mixed 1:2:4. Reinforcement was used in the form of welded steel wire mesh, 65 lbs. per 100 sq. ft., and ½-inch round corrugated iron bars 10 feet long bent to a right angle and placed at each corner of each 33-foot block. Carey elastite ½-inch by 6 inches was used for expansion joints. The subgrade was crowned, thoroughly rolled and compacted with a 10-ton roller. The pavement was made uniformly 6 inches thick and was constructed one-half the width of the roadway at a time. The curb was made 6 inches by 18 inches with a 2-inch batter on the back and was set on a foundation containing 3-inch porous drain tile with joints protected by 3-inch strips of 2-ply tar paper, imbedded in 8 inches of cinders, wet and tamped.

EQUIPMENT AND ORGANIZATION

The equipment used consisted of a Ford truck, steam roller, teams hired at $5 per 8-hour day; screen, elevator and bins operated by a 9 h.p. gasoline engine rented at $1 per working day; drag scrapers to haul gravel from bank to hopper; a Rex 10-E paver mixer, steam operated, chute discharge, bought second hand for $1,500; and a Sheldon gasoline operated barrel mixer for curb concrete, bought new for $147.50.

Common labor received $2.75 for 8 hours. The owner of the gravel pit received 25c per cubic yard for gravel measured in place in the pavement. Cement was bought through local dealers at $2.98 per barrel, net.

The gravel was hauled from the bank into the hopper with drag scrapers, which averaged 90 cubic yards per day. Here it was elevated and screened and everything passing through a ½-inch circular screen was classed as sand, and the larger material passing through a 3-inch circular screen was used for coarse aggregate. The hauling of the aggregate was sublet for 85c per cubic yard measured in the truck box, the average haul being 2¾ miles.

The field party consisted of a transitman, rodman and chainman, the last acting as timekeeper. The pit gang consisted of a foreman, a mechanic, 12 laborers and three teams. The grading gang consisted of a foreman, 15 laborers and two teams. The curb form gang consisted of a boss carpenter, a helper and a laborer. The curb concrete gang consisted of one foreman (who was also the finisher), and six laborers. The

ONE HALF OF NORTH MAIN STREET COMPLETED

paving concrete gang consisted of a foreman, engineer, fireman, mechanic and 18 laborers. The Ford truck was served by a chauffeur and helper; the steam roller by one operator.

WORK DONE

The North Main Street job consisted of pavement 2,450 feet long and 24 feet wide containing three intersections, on which was laid 1,109.8 cubic yards of concrete pavement and 5,000 lineal feet of curb. The time required to complete this job included 16 days of grading, 23 days on curb excavation, 30 days on curb forms, 28 days on curb concrete and 19 days on paving. Grading began with the entire grading gang on July 12; on July 16 the curb gang started, and on August 1, the paving was started, when all but 6 of the grading gang were put to work with the paver; leaving a reduced grading gang to grade the other two streets.

The Water Street job was 933 feet long, 635 feet of this being 30 feet wide and the balance 24 feet wide, with one intersection. It included 1,837.7 lineal feet of curb and 484.4 cubic yards of concrete pavement. Nineteen days were occupied in grading, 13 days in curb excavation, 12 days on curb forms, 12 days on curb concrete and 8 days on paving.

The Bridges Avenue job was 1,035 feet long, 400 feet of which was on a curve around a park. It was 24 feet wide and contained five intersections. There were 2,010 lineal feet of curb and 521.7 cubic yards of concrete pavement. Grading occupied 19 days, curb excavations 15 days, curb forms 14 days, curb concrete 13 days and paving 12 days. On account of delay in receiving cement, the labor force on this street was reduced one-half.

SCREENING OUTFIT

COSTS

The itemized cost of the work is shown in the accompanying table. Item No. 2 includes those given as 4-A, 6 and 7 and also the cleaning of the finished pavement and grading alongside the curb and sidewalk. The "overhead" includes engineering, office, printing, bank interest and freight charges. The engineer's estimate before receiving bids was $39,352.75. The cost of the plant used was $3,741.46, which was estimated to have a value at the end of the contract of $3,086.05, giving a depreciation of $655.41 to be added to the cost given above. Using the unit price of the lowest bidder on the work, the cost by contract would have amounted to $39,200.43.

In estimating the cost of the sand and gravel, the cost of the screening plant complete for operation was $762.82; the labor cost, including stripping, was $3,791.56, and miscellaneous supplies, $178.76; giving a total cost of $3,970.32. The total output of gravel and sand for the season was 3,857.7 cubic yards, giving an average cost of screening of $1.03 per cubic yard. The screening yielded an excess of sand amounting

METHOD OF PLACING CURB FORMS

to about 500 cubic yards, which has been put into a stock pile for future use.

COSTS

No.	Item	Quantity	Unit Cost	Total Cost
2	Earth excavation	1500 CY		$3045.57
4A	L. F. 15-in. tile	180		
6	Catch basins	9		
7	Changing elevation of M. H.	16		
8	C. Y. cement concrete pave. 1:1½:3 mix	2115.94	4.79	10135.35
8A	Bbls. Portland cement	4021	2.98	11990.58
8B	Expansion joint L.F.	12148	.08	971.84
9	L.F. 6-in. by 18-in. curb	7848		
	L.F. 6-in. by 18-in. curb (curve)	1000	Aver.674	5963.55
10	Sq. ft. metal reinf.	112265	.03	3367.95
11	Lbs. misc. iron and steel	10000	.03	300.00
	Overhead			2159.79
	Total			$37834.63

UNIT COSTS
Per Lineal Foot

Curb	North Main St.	Water St.	Bridges Ave.
Tile	.05	.05	.05
Cinders	.01	.01	.01
Forms	.01	.01	.01
Cement	.136	.159	.141
Sand	.026	.026	.026
Stone	.058	.058	.058
Supplies	.008	.017	.016
Labor	.308	.343	.371
Deprec.	.02	.02	.02
	$0.626	$0.693	$0.702

AGGREGATE AND REINFORCEMENT DEPOSITED ALONG ROAD

Per Cubic Yard

Paving		
Cement	5.348	5.345
Sand	.778	.778
Stone	1.700	1.700
Reinf.	1.520	1.520
Exp. joint	.555	.555
Supplies	.157	.200
Coal	.040	.040
Ford operation	.302	.302
Depreci.	.200	.200
	$12.120	$12.295

Motor Taxes in Michigan

The Michigan Legislature in 1921 appointed a joint legislative committee of inquiry into taxation which has reported to the 1923 legislature a number of findings and recommendations. Among these two are of special interest to owners of automobiles. The first is "that there should be a graduated tax of $25 to $250 on motor trucks and buses operating on State highways, and that the control of these vehicles should be vested in the public utility commission." The second is that "a tax of 1 cent per gallon should be levied upon gasoline for the support of public highways."

Federal Aid Roads in 1922

The Bureau of Public Roads reports that during the year 1922, 7,469 miles of road projects were completed and 17,978 miles were under construction and approximately half completed. Federal aid to the amount of $166,911,552 was actually paid out to the states.

Texas had the largest completed mileage for the year, 933, while more than 500 miles was completed by each of the states of Arkansas, Georgia, Iowa, Minnesota and North Carolina. Texas also received the largest payment of federal aid, this amounting to $5,915,046, while nearly $2,500,000 more was earned. Between $4,000,000 and $5,000,000 was paid during the year to each of the states of Illinois, Iowa, Ohio and Pennsylvania.

COMPLETED PAVEMENT WITH BANKED CURVE

South Carolina Road Work

South Carolina during 1922 built 80 miles of hard surface roads at an average cost of $24,025 a mile; also about 500 miles of top-soil or sand-clay roads at an average cost of $6,643 per mile. The total expenditure for highways and bridges was nearly $6,000,000.

At the first of this year more than $5,000,000 of construction work had been either contracted for or projected. This is entirely independent of the road-building program contemplated by the proposition to be submitted to the voters of raising $50,000,000 by road bonds.

Virginia's New Highway Department

A reorganization of the State Highway Department of Virginia was required by acts of the 1922 General Assembly, and the reorganization became operative on January 1, 1923.

The new department is in charge of five commissioners, selected from the five geographical divisions of the State but each representing the whole State rather than his division. One member of the commission is to be chairman and devote his entire time to the work and will be the executive of the commission.

There will be two principal departments, executive and engineering, the former having sub-departments of auditing, purchasing, legal, right of way, and statistical and filing.

Engineers have been appointed by George B. Coleman, state highway commissioner of Virginia, in his plan for reorganizing the engineering branch of the department. The assistant engineers will be C. S. Mullen, in charge of construction; J. J. Forrer, in charge of maintenance; W. R. Glidden, in charge of bridges; A. H. Pettigrew, in charge of state aid; B. P. Harrison, in charge of service; Tazewell Ellett, in charge of office; Shreve Clarke, in charge of tests; and E. M. Evans, in charge of equipment.

Eight districts have been laid out, each to be in charge of a district engineer, while each district will be sub-divided into five residence districts, each in charge of a resident engineer. The

district engineers selected are: George T. Lemmon, A. H. Bell, R. P. Ellison, J. C. Albright, C. D. Scott, H. T. Ammerman, T. F. Loughborough and J. D. Keeler, Jr.

Pennsylvania Road Bonds

The Pennsylvania Legislature is considering a bill providing for an amendment to the Constitution which would enable the commonwealth to bond itself for $100,000,000 for road construction purposes. This bill has already passed the 1921 Legislature and if it passes this one will be submitted to the people, probably at the election in November, 1924, and, if it is approved then, the 1925 Legislature can pass the enabling legislation. The State is already bonded for $50,000,000 for good roads.

Resurfacing Assessments in Indiana

A bill is being considered by the Indiana Legislature that would transfer a large part of the cost of resurfacing streets from the abutting property owner, who now pays it, to the taxpayer. The bill provides for creating a special fund by a tax levy not exceeding 5c. on every $100 of taxable valuation. Seventy-five per cent. of all street repairing and resurfacing would be paid from this fund, the other 25 per cent. being charged against the owners of the abutting property.

Tests of Relative Road Wear

The U. S. Bureau of Public Roads last year prepared, at the Arlington Experiment Station, a test road for investigating the relative wear of various concrete surfaces and also of bituminous mixtures of different qualities. For this purpose a circular roadway was built 625 feet in outer circumference. A concrete track is on the outside of the circular roadway, while immediately adjacent to this and within it is a track paved with bituminous surfaces.

There are 62 sections of concrete road paved with different qualities of concrete. These are being subjected to the wear of rubber-tired truck wheels. The inner track is composed of 27 sections of asphaltic concrete of different mixtures. The bituminous pavement will be subjected to actual motor truck traffic for the purpose of studying the laws governing the stability of bituminous mixes. "This investigation has been instituted with the idea of rendering bituminous roads less likely to wave under traffic." Before beginning the experiments, measurement of the profile of the surface was taken with an autographic profile device contrived especially for this purpose. The profile measurements will be repeated at frequent intervals as the tests progress in order to determine the location and amount of wear or other deterioration of the surface. The lack of stability of the bituminous pavement will be studied by means of brass plugs placed in the surface with their positions exactly noted.

In the test of the concrete track a special contrivance is used which rolls on the concrete and is guided by wheels traveling on rails. Two solid rubber-tire wheels loaded with 600 lbs. per inch width of tire (approximately that of a 5-ton truck) will travel over the pavement at a speed of 20 miles an hour, the power being transmitted as current to a motor on one of the wheels which will thus act as the drive wheel of a truck. These wheels can be run continuously in a single track, or can be moved toward or away from either edge, and the weight can be varied. Traveling at 20 miles an hour around a circumference of 625 feet would mean that this pair of wheels would pass over each section of pavement 1,350 times in an eight-hour day.

State Zoning Enabling Act

Some time ago an advisory committee on zoning was appointed by Secretary Hoover consisting of Edward M. Bassett, Irving B. Hiett, John Ihlder, Morris Knowles, Nelson P. Lewis, J. Horace McFarland, Frederick Law Olmsted and Lawrence Veiller. This committee prepared a form for a state zoning enabling act which it recommends be adopted by the various states, with certain additions conforming to the practice of the several states such as the title and enacting clause, repeal clause, date of taking effect, etc. A revised edition brought up to to January, 1923, is ready for distribution by the Department of Commerce at Washington.

The committee recommends that this enabling act be adopted in each state, even though it may be thought that the powers contained in home rule charters are sufficient to enable a municipality to undertake zoning without any special legislation. Some zoning ordinances have been set aside because the municipality had not been granted the specific power to do that which zoning implies, and the safest procedure would seem to be to adopt this enabling act in every state. No amendment to the state constitution is necessary, as a rule, since zoning is undertaken under the police power and is well within the powers granted to the legislatures of the various states by the state constitutions.

Improvement District for Sea Wall

County Engineer A. B. Pimm is working on plans for a sea wall along a boulevard extending from the city limits of Tampa, Florida, half the cost of which will be borne by the county and the remaining half by property owners lying within an improvement district which it is proposed to have created by special legislation. The proposed legislation provides that assessments be made on property holders on a graduated scale for a distance of 2,800 feet back from the boulevard along which the sea wall will run.

Present plans provide for construction of a sea wall 120 feet from the property line, there being a 10-foot sidewalk adjacent to the property, a 24-foot paved highway, a 50-foot parkway for street-car tracks, another 24-foot paved highway, and a 10-foot sidewalk adjacent to the sea wall. The sea wall will be 8 feet high and quite similar to one now existing in the city, with lighting standards at regular intervals.

Paving Statistics of Cities

Information furnished to Public Works by city officials, giving kinds and amounts of pavement laid in city streets during 1922, and information relative to reinforcement used, practice as to replacing cuts made in pavements by private parties, payment for paving and repaving, and other details.

The information concerning paving in city streets which we have collected this year, as for the past fifteen years, through the kind co-operation of city engineers, superintendents of streets and other city officials, is so abundant in amount that it has been found impracticable to give it all in this issue, but readers will find in the following tables and in the articles on "Pavement Reinforcement," "Bonds and Deposits for Trenching Permits" and "Paving Notes" information that will well repay careful reading. The balance of the tables will be published in a following issue, giving the areas and costs of the various kinds of pavements not covered in this one. Also, replies to our questionnaire are continuing to come in and supplementary statistics compiled from these will be published later.

In the table, "Replacing Trenches," the questions asked were: "Who backfills street trenches, city or party who opens them?" "Who replaces pavement?" "If city backfills or replaces, what charge is made to the parties who did the excavating?" "What special regulations have you for backfilling trenches?" In tabulating the replies to the first question, the word "owner" is used to designate plumber, contractor or other party presumably hired to dig the trench by the owner of the property for whom a service is laid or the owner of the pipe or other structure for which the trench is dug, as distinguished from city employes or departments. A summary of the information in this table is given elsewhere in this issue.

In the table, "Payment for Repavement," the questions asked were: "What percentage of original pavement is paid by abutting property?" "What percentage of repaving is paid by abutting property?" "Are sand-clay, gravel and macadam classed as 'pavement' in applying this regulation or law?" The chief reason for the last question is that in some cities a property owner who has paid for a avement in front of his property is not required to pay for repaving when this is worn out, but macadam is not considered to be a pavement and a pavement that replaces macadam must be paid for by the abutting owner.

In the tables giving amount and cost of pavement laid, reference is made to city streets only; areas are given in square yards (square feet for sidwalks) unless otherwise stated, and costs are per square yard (except for sidewalks) or for the entire improvement. Foot notes indicate the features of the improvement that are covered by the cost, these ranging, with all variations, from laying a wearing surface on an old base to grading, base and top, laying sewers, building catchbasins, curbs and sidewalks, with cost of inspection, advertising for bids, etc., all combined in one figure and divided by the yardage of pavement laid.

Some of the information contained on the questionnaires returned could not well be given in tables or footnotes and much of this has been written out in the form of "Paving Notes," which give details of unusual features of paving work.

(*Continued on page 74*)

REPLACING TRENCHES

For brevity, the word "owner" is used below to designate the party opening the trench—corporation, plumber, etc.

City.	Who Backfills Street Trenches?	Who Replaces Pavement Over Trenches?	What Charge Does City Make?	Special Regulations for Backfilling.
Alamaba				
Birmingham	Owner	City	Estimated actual cost	Tamp in 6-in. layers
Arkansas				
Searcy	Owner	City	.....	None
California				
El Centro	Owner	City	Actual cost	None
Oakland	Owner	City	Cost	City Supervision
Riverside	Owner	City	Cost plus 10%	Dry tamp on paved streets
Santa Rosa.....	Owner	City	Cost	Tamp in 4-in. layers, settle with water
So. Pasadena.....	Owner	City	$3.15 per sq. yd.	Put back all the dirt
Vallejo	Gas Co. its trenches, city all others	Same	.....	Tamp carefully, pav't equal to that removed
Visalia	Owner	City	Cost	Thoroughly puddle
Whittier	Owner	City	Cost	Flood and tamp
Colorado				
Denver	Owner	City	$5.00 per sq. yd.	Tamp in 6-in. layers, city supervision
Fort Collins.....	W. W. City; other, owner	Same	Actual cost	Tamp around structures and puddle
Longmont	Owner	City	.....	Puddled, satisfaction of street com'r
Monte Vista.....	Owner	.....	.....	Generally puddle
Pueblo	Owner	City	.....	Wet and tamp
Connecticut				
Ansonia	Owner	Owner		By person satisfactory to city engineer, under inspector if he wishes
Bridgeport	Owner	City	Cost	.....
Bristol	Owner	Owner or city	Total cost	Leave as good as found

City.	Who Backfills Street Trenches?	Who Replaces Pavement Over Trenches?	What Charge Does City Make?	Special Regulations for Backfilling.
Connecticut (Continued)				
Greenwich	Owner	Owner	.....	.....
Hartford	Owner	City's contractor	.....	Tamp suitable material in 6" layers, or puddle
Middletown	Owner	Owner; sheet asphalt by paving contractor	Owner pays contractor	
New Haven	Owner	City	Cost	.....
New Britain	Owner	City	$3 per sq. yd. on macadam base, $5 on concrete	.....
Putnam	Owner	Owner	.....	Approval of street sup't.
New London	Owner or city	City for permanent pav't	Cost plus 10%	Rules printed on permit
Willimantic	Owner	City	Actual cost	None
Delaware				
Wilmington	Owner	City	.....	Tamp by hand or machine
District of Columbia				
Washington	Owner	City	Various	Special regulations
Florida			.....	
Key West	Owner	City	$5 per sq. yd.	Water tamp
Tallahasse	Owner	Owner	.....	.....
Georgia				
Americus	Owner	Owner	.....	Ditches puddled, city inspection
La Grange	Owner	City	.....	.....
Idaho				
Boise	Owner	City	Cost	Puddle
Pocatello	Owner	City	$3 per sq. yd.	Puddle in 6-in. layers, tamp
Illinois				
Benton	Owner	Owner	.....	None
Canton	Owner	City	Actual cost	Satisfactory to street sup't.
Carterville	Owner	Owner	.....	Well puddled
Centralia	Owner	City	$4.75 per sq. yd.	.....
Champaign	City	City	Actual cost of labor and materials	Carefully tamped; slab reinforced as a beam with 12-in. shoulder on solid earth
Chicago	Owner	City	.....	Water and tamp in 6" layers
Chicago Heights	City	City	.....	Backfill with sand
Clinton	Owner	Owner	Actual cost	None
Collinsville	Owner	Owner	.....	Ordinance regulations
Danville	City	City	Cost plus 10%	Tamp in 4-in. layers; puddle if sandy soil
Decatur	City	City	Cost	City forces, direction of street sup't
Dekalb	Owner	Owner	.....	Good condition as before
Duquoin	Owner	Owner	.....	.....
East Moline	Owner	Owner	.....	Satisfy city eng'r and street com'r
East St. Louis	Owner	Owner	.....	Tamp or flood under city inspector
Edwardsville	Owner	Owner	.....	.....
Galena	Owner	Owner	.....	None
Granite City	Pub. Serv. Corp.	Same	.....	.....
Joliet	Owner	City	Brick $4.50 per sq. yd., $10 min.; asphalt, $5 for 6 yds. or less; over 6 yds, $3.50	Tamping, flooding and shoulders
La Grange	City	City	Total cost	Tamp in 6-in. layers, cover with 8-in. concrete slab 3 ft. wider and longer than excavation.
Macomb	Owner	Owner	.....	None
Marion	Owner	Owner	.....	None
Mattoon	City	City	Actual cost	None
Moline	City	City	Exact cost	Settle about 3 mos. before paving
Naperville	Owner	.....	.....	Flushing and tamping
Normal	City	City	$20 to $30	Tamped
Oak Park	Owner	Asphalt, village, brick and macadam, owner	.....	Tamp in 6-in. layers, flood where soil permits
Ottawa	Owner	Owner	.....	Tamp and flush
Pana	Owner	Owner	.....	Filled with gravel, flooded, compacted
Quincy	City	City	Dirt streets, $3 per sq. yd.; paved, $5	Tamp in thin layer; for pavement, 6-in. reinforced concrete base
Riverside	Owner	Village	.....	Puddle and tamp
Robinson	Owner	Owner	.....	Under city supervision
Rockford	Owner	City	.....	.....
Waukegan	City	City	Actual cost	Under pavements, sand backfill
Winnetka	City	City	Cost	Use all sand under pavements
Indiana				
Bedford	Owner	Owner	.....	.....
Boonville	Owner	Owner	.....	Under city supervision
Decatur	Owner	Owner	.....	.....
Elwood	Owner	Owner	.....	None—very unsatisfactory
Fort Wayne	Owner	City	Sliding scale	Tamp in 6-in. layers
Gary	Owner	Owner or city	Cost	None
Huntington	Owner	Owner	.....	Tamp in layers
Marion	City, if paved	City	Labor and materials	Contractors and plumbers bonded
Martinsville	Owner	Owner	.....	.....
Peru	Owner	Owner	.....	Supervision of city eng'r and street com'r
Portland	Owner	Owner	.....	Supervision city eng'r
Richmond	City	City	Actual cost plus 12%	.....
Seymour	Owner	Owner	.....	Supervision of city eng'r
Shellyville	Owner	Owner	.....	Replace in first class condition
South Bend	Owner	City	Cost	Tamp
Terre Haute	Owner	City	$5 per sq. yd.	Must be flushed
Vincennes	Owner	Owner	.....	Dirt tamped, water added
Wabash	Owner	City	Total cost	Tamp and flush. Cut only between May and Nov., except emergency
Winchester	Owner	.....	.....	.....
Iowa				
Albia	Owner	Owner	.....	Fill with sand under pavements, flush elsewhere
Cedar Rapids	Owner	City	Actual cost	Tamp or flush
Chariton	Owner	Owner	.....	None
Clinton	Owner	City	Cost	Flushed if sandy, tamped if clay
Creston	City	City	Estimated cost of filling and paving	Tamp in 4-in layers; 1:8 cinder concrete in tunnels

City.	Who Backfills Street Trenches?	Who Replaces Pavement Over Trenches?	What Charge Does City Make?	Special Regulations for Backfilling.
Iowa (Continued)				
Decorah	Owner	Owner	.....	Flush; 12-in. shoulder for concrete base
Eagle Grove	Owner	City	Total cost	Hand tamped or flushed
Emmetsburg	Owner	City	.....	.....
Fort Dodge	Owner	City	.....	Tamp and flush to within 10-in. of subgrade, concrete base 10-in. thick
Glenwood	City	Owner	Cost	.....
Keokuk	City, if paved	City	Exact cost	.....
Muscatine	City, if paved	City	Exact cost	City engineer notified, street commissioner does work
Oskaloosa	Owner	Owner	$5 per sq. yd. of maintenance	Tamp in 9" layers
Ottumwa	Owner	Owner	.....	Tamp in 2" layers, or tamp and flood 24 to 48 hrs. For pavements, 6" or 8" reinf. concr. slab
Sioux City	Owner	City	.....	Tamped under city inspection
Spencer	Owner	Owner	.....	Well tamped and settled
Waterloo	City	City	1½" sheet asph., $6.50; 2", $7; 2" asph. cover, $6.50; brick or wood block, $7; brick on macadam base, $2.50; concrete, $4. Backfilling, $1.25 per cu. yd.	.....
Kansas:				
Atchison	City	City	$3.60 to $6.30	.....
Chanute	Owner	.....	.....	Water tamping where practicable
Columbus	Owner	City	Cost	.....
Fort Scott	City	City	Labor and material	Return all material by tamping
Independence	Owner	Owner	.....	Tamp 6" layers; city furnishes tamping machine
McPherson	Owner	City	.....	None
Paola	Owner	Owner	.....	Inspected by street department
Salina	Owner	Owner	Actual cost	Satisfactory to city engineer
Wichita	Owner	City	$5 to $7 (kind and age of pavement)	.....
Kentucky:				
Ashland	Owner	City	Actual cost	Must be tamped
Corbin	Owner	Owner	.....	.....
Lexington	Owner	City	.....	Flushing
Ludlow	Owner	Owner	.....	.....
Paducah	City	City	Actual cost	Deposit and indemnity bond
Richmond	Owner	Owner	.....	None
Maine:				
Augusta	Owner	Owner	.....	Either tamp or fill trench with water
Bangor	Owner	City	Gravel, $1; macadam, $2.50; concrete, wood block, brick, $4	Satisfy superintendent of streets
Gardiner	Owner	Owner	.....	Return all material tamped dry
Lewiston	Owner	City	Cost	.....
Portland	Owner	City	Bitulithic, brick, wood blk., $4; all others, $2.50	Tamp 12" layers, sometimes puddled, material dry in freezing weather
Rockland	Owner	City	Actual cost	None
Maryland:				
Hagerstown	Owner	City	Cost plus 10%	.....
Salisbury	Owner	City	Cost	Compact in 12" layers, upper part damp
Massachusetts:				
Athol	Owner	Owner	.....	As good as found
Attleboro	Owner	City	.....	None
Brockton	Owner	City	Actual cost	None
Brookline	Owner	Town	.....	Satisfaction of supt. of streets
Easthampton	Town	Town	Cost plus 5%	Tamp in 6" layers
Fitchburg	Owner	City	Actual cost	.....
Greenfield	Owner or city	Same	Cost including overhead	.....
Hudson	Town or Gas Co.	Town	Cost	None
Lowell	Owner	Owner; city stone block	.....	.....
New Bedford	Owner	Gas & Tel. Cos., others by city	.....	None
North Adams	Owner	City	Actual cost	Well tamped
Peabody	Owner	City	Total cost	Ram and puddle
Pittsfield	Owner	City	Actual cost	None
Rockland	Town	Town	Cost	None
Waltham	Owner	City	Cost	None
Webster	Owner	City	None	None
Worcester	Owner	City	Total cost	Leave in as good condition as found
Michigan:				
Ann Arbor	Owner	City	Cost	Tamp
Benton Harbor	Owner	City	Actual cost	None
Cadillac	Owner	.....	.....	Water and tamp
Detroit	Pub. utilities; city for others	City	Cost of labor, materials and inspection	Well tamped. Selected material if original material not satisfactory
Dowagiac	Owner	City	Cost	Replace all dirt
Grand Rapids	Owner	City	Cost plus 10%	Thoroughly tamp and flush
Hastings	City	City	.....	.....
Holland	Owner	City	Cost	Now under preparation
Houghton	City	City	.....	.....
Iron Mountain	City	City	Actual cost	Puddle all trenches
Ironwood	Owner	City	Cost	Tamp in 6" layers or puddle
Kalamazoo	City	City	Cost	.....
Mt. Clemens	Owner	Owner	$1 for inspection	Hand tamp and puddle; stand two weeks before repaving
Muskegon	City	City	Cost	Tamp in 6" layers and puddle
Muskegon H'ghts.	Owner	.....	.....	None
Negaunee	City	City	Actual cost	Hand tamp and flush
Niles	Owner	Owner	.....	.....
Owosso	City	Owner	Cost plus 10%	Tamp under pavements
Pontiac	Owner	City	.....	Tamp and flush, city inspection
Port Huron	Owner	City	.....	.....
Saginaw	City	City	.....	Puddle, flush periodically for 1 year. If to be paved earlier, use 1 sand to 1 clay
Sault Ste. Marie	Owner	City	Actual cost	City inspection

City.	Who Backfills Street Trenches?	Who Replaces Pavement Over Trenches?	What Charge Does City Make?	Special Regulations for Backfilling.
Michigan (Continued)				
Sturgis	City	City	Total cost plus 25%	Under pavements, flush and hand tamp
Minnesota:				
Albert Lea	Owner	City	Actual cost	Ordinances
Austin	Owner	City	$50	Flush and tamp
Brainerd	Owner	City and owner	Actual cost	Careful and safe manner
Duluth	City	City	Total cost	Use sand or gravel only
Ely	Owner	.....	.....	None
Faribault	Owner	Owner	Cost	Replace original condition. Plumber's bond
Little Falls	Owner	City	Cost	Sandy soil. Puddle
Mankato	Owner	City	Cost	Bond and city supervision
Minneapolis	Owner	City	.....	Inspection by city engineer
New Ulm	Owner	City	Total cost	None. Sand and gravel soil
Rochester	Owner	Owner	.....	Tamp and flush. Sand refill under pavements
St. Cloud	Owner	City	Cost plus 10%	Water and tamp in 6" layers
So. St. Paul	Owner	Owner	Cost of inspection	Wet well and tamp in 6" layers
Willmar	Owner	Owner	.....	Flush
Winona	Owner	City	$3 with concrete base, $1.50 if no base, $2 for macadam	Water and tamp
Mississippi:				
McComb	City	City	Actual cost	.....
Missouri:				
Boonville	City	Owner	.....	None
Brookfield	Owner	Owner	.....	Under pavements, refill with sand
Cape Girardeau	Owner	City	Actual cost	Tamp or flood
Excelsior Springs	Owner	Owner	.....	Bond to keep in repair
Fulton	City	City	Actual cost	.....
Hannibal	Owner	Owner	.....	City engineer's inspector
Joplin	Owner	City	Actual cost	Tamp and settle thoroughly before paving
Kansas City	Owner	City	Concrete, $3.75; w'd. block, $8; asph., $6; brick & stone block, $5.50; macadam, $3	Tamp and flush
Kirksville	Owner	.....	.....	.....
Maplewood	Owner	City	$10 for 10 sq. ft.	None
Marshall	Owner	Owner	.....	Hand tamp and flood; eng'r directs
Monett	City	City	Force account	None
St. Joseph	Owner	City	.....	City will backfill and use sand
St. Louis	Owner	City	Cost	Properly tamp in layers
Sedalia	City	City	Exact cost	Tamp in 4" layers. Cut back old pavement 4"
Montana:				
Anaconda	Owner	City	Actual cost	Flush and hand tamp
Billings	Owner	Owner	Exact cost	Engineer's directions. Surety bond
Bozeman	Owner	Paving Co.	Paving Co.'s bill	Flush or tamp in layers
Butte	Owner	City	$35 to $10 per sq. yd.	Tamp 9" layers, 40-lb. tamper; or puddle
Helena	Owner	City	$5 per sq. yd.	Tamp in 3" layers
Kalispell	Owner	City	Cost	Licensed plumber maintains for 1 yr.
Lewistown	City	City	.....	Water settle and tamp
Livingston	Owner	Owner	.....	Under city engineer's supervision
Nebraska:				
Chadron	Owner	City	Cost plus 10%	Tamp dry
Columbus	Owner	City	Actual cost	Tamp in 9" layer. Fill with sand under pavements
Fremont	City	City	Actual cost	Tamp or flood; replace all earth
Grand Island	Owner	City	Cost	Puddle
Hastings	Owner	City	Cost plus 20%	Fill 1½ ft., fill trench with water and backfill rest
Lincoln	City	City	Cost plus 10%	Permit $10 for 1 yr. after paving, $5 2d yr., $3 3d to 5th, $1 thereafter
Norfolk	City	City	$2 per cu. yd. for fill, $5 per sq. yd. for paving	Must fill by hand
North Platte	Owner	Owner	.....	Return all dirt, tamp and puddle
Omaha	Owner	City	.....	.....
Scottsbluff	Owner	Contractor	.....	None
New Hampshire:				
Berlin	Owner	Owner	.....	.....
Laconia	Owner	City	$2.50 per sq. yd.	.....
Nashua	Owner	City	Cost	Satisfaction of city
Portsmouth	City	City	Cost plus $5	.....
New Jersey:				
Bergenfield	Owner	Owner	.....	Replace in original condition
Bridgeton	Owner	Owner	.....	Saturate well and tamp
Camden	Owner	City	$4 per sq. yd.	.....
Cape May	Owner	Owner	.....	.....
Clifton	Owner	.....	.....	Inspected by street department
Edgewater	Owner	Owner	Cost	Ram and puddle
Freehold	Owner	Owner	.....	.....
Millville	Owner	Owner	In paved streets charge per sq. yd. as damages	Satisfaction of city
Newark	Owner	Pub. Serv. Co. blk pavements, city all others	.....	None
New Brunswick	Owner	City	Cost	Thorough tamping
Phillipsburg	Owner	Town	Brick $3.60, macadam $0.90, dirt $0.45	None
Plainfield	Owner	City	Depends on type	None
Roselle Park	Owner	Borough	Water and gas co.'s cost; others flat rates per sq. yd.	None
Rahway	Owner	City	Cost	Tamp in 6" layers satisfactory to engineer
Rutherford	Owner	Borough	Av. $11 per opening	Tamp in 6" to 12" layers, puddle if required
Salem	Owner	City	Cost	Puddle and tamp
So. Orange	Owner	Owner	.....	None
Summit	Owner	Owner or city	Actual cost	Supervision of city engineer
Trenton	Owner	Owner or city	.....	.....
Wallington	Owner	Owner	.....	.....
New Mexico:				
Albuquerque	Owner	City	.....	Water-tamp
Roswell	Owner	City	Cost	.....
Santa Fe	Owner	Owner	.....	None

City.	Who Backfills Street Trenches?	Who Replaces Pavement Over Trenches?	What Charge Does City Make?	Special Regulations for Backfilling.
New York:				
Amsterdam	Owner	City	Actual cost	.....
Auburn	Owner	Owner or city	Cost	Replace in original condition
Binghamton	Owner	Owner	.....	Replace in as near former condition as possible
Buffalo	Owner	City, by contract	.....	Tamp in 6" layers if clay. Temporary pavement in winter
Cohoes	Owner	Owner	.....	None
Corning	City	City	Cost of fill	Tamping machine used
Cortland	Owner	City	Actual cost	Tamp in 6" layers
Endicott	Owner	Owner	.....	None
Fulton	City	City	Cost	None
Geneva	Owner	City	Actual cost	Tamp dry, one shoveler to 2 tampers
Glens Falls	Owner or city	City	Actual cost	None, unfortunately
Gloversville	Owner	City	Actual cost	None
Herkimer	Owner	City	Total cost	Tamp in 6" layers, wet if necessary
Ithaca	Owner	Owner	.....	Two tampers to 1 shoveler
Jamestown	Owner	City	Actual cost	Wet down and thoroughly tamp
Johnson City	Owner	Owner	.....	Puddle and tamp
Kingston	Owner	City	Cost	Puddle, take care of till settled
Lackawanna	Owner	Owner	.....	Wet and tamp in 12" layers
Lancaster	Owner	Owner	.....	Supervision of street commissioner
Little Falls	Owner	Owner	Cost plus 10%	Any reasonable direction of city
Lockport	Owner	Owner	.....	One tamping to two shoveling. Puddling allowed
Massena	Owner	Village	Actual cost	Puddle and tamp thoroughly
Newburg	City	City	All cost	.....
New York — Manhattan Borough.	Owner	City or Pub. Serv. Corp.	.....	.....
Niagara Falls	Owner	Owner	Cost	Fill with crushed stone if to be paved at once
No. Tonawanda	Owner	Owner	.....	None
Ogdensburg	Owner	Owner	.....	Dry material well tamped
Olean	Owner	Owner	.....	Tamp in 12" layers—sometimes soak afterwards
Oneida	Owner	Owner	.....	None
Port Chester	Owner	Village	Cost plus $5.00	None
Poughkeepsie	Owner	City	Fee for opening and cost of repairing	Direction of city inspector
Rochester	Owner	Owner	.....	Tamp in 6" layers
Schenectady	Owner	Base by owner, top by city	.....	Use water
Watertown	City	City	Cost of sand, trucking and repaving	Backfill with sand
Waverly	Owner	Owner	.....	.....
North Carolina:				
Asheville	Owner	City	.....	.....
Charlotte	Owner	City	.....	None
Durham	Owner	City	Rates per sq. yd. for each type	.....
Greensboro	Owner	City	$8 per sq. yd.	.....
Mount Airy	Owner	City	Actual cost	Inspector's instructions
North Dakota:				
Fargo	Owner	City	Actual cost	Backfill with gravel and plank
Grand Forks	Owner	Owner	.....	Use reinforcing rods over trench
Minot	Owner	City	Cost	Tamp or puddle under city superv'n
Wahpeton	Owner	City	Cost	Backfill with gravel or cinders, leave open until settlement ceases
Ohio:				
Akron	Owner	City	.....	Tamp; puddle in some cases
Alliance	City	City	$1 per lin. ft. for sewer, 25c. per lin. ft. for water	.....
Ashtabula	City if paved, 1 owner otherwise	City	Cost	Flush or tamp
Bellaire	Owner	City	Actual cost	Tamp or flood with water
Bellevue	Owner	Owner	.....	None
Bucyrus	Owner	Owner	.....	Tamp to within 13" of surface, open 1 ft. wider on each side, place 8" of concrete, pave
Cambridge	City	City	.....	.....
Chillicothe	Owner	Owner	.....	Well watered
Cincinnati	Owner	City	Cost	Well tamped, flushed if necessary
Columbus	City or utility co.	Same	.....	.....
Conneaut	Owner	City	Actual cost	Fill 2 ft. over pipe, fill with water, throw in dirt
Dayton	Owner if dirt or gravel, city if paved	City	$1.25 for brick or concrete, $1.50 for asph. or granite. More if more than 2 ft. wide or 7 ft. deep	Must be flushed
Delaware	Owner	City	Actual cost	Settle with water if over 3 ft. deep
East Youngstown.	City if paved, owner otherwise	City	Cost plus 5%	Tamp and flush, settle two weeks
Elyria	Owner	City	Actual cost plus 15%	Tamp or flush, city engineer superv'n
Findlay	City	City	Cost	Two tamping to 1 backfilling
Greenville	Owner	Owner	.....	Tamp 12" above structure, fill half full and flood, fill balance in water. Concrete base 12" wider than trench on each side
Ironton	Owner	Owner	.....	Tamp or flush under city direction
Lakewood	Owner	City	Brick $7; asphalt $10	Backfill with sand tamped and flushed
Lancaster	Owner	Owner	.....	.....
Marion	Owner	Owner	Cost	Tamp or flush
Middletown	Owner	City	Concrete and bit mac. $3.60, wood block, brick & asph. $5.40	Flush under inspection
Newark	City	City	Actual cost	None
Niles	Owner	City	Actual cost	Maintain until repaved
Oberlin	Owner	Village	Cost plus 10%	Tamp
Ravenna	Owner	City	.....	Tamp and flush
Salem	City	City	Cost	Tamp or flush
Struthers	City where paved, owner elsewhere	City	Cost plus 5%	Flush and tamp, settle several weeks
Troy	Owner	City	Actual cost	Flush

City.	Who Backfills Street Trenches?	Who Replaces Pavement Over Trenches?	What Charge Does City Make?	Special Regulations for Backfilling.
Ohio (Continued)				
Warren	Owner	City	Actual cost	Tamp dry dirt in 6" layers, remove wet dirt
Washington C. H.	Owner	City	.....	.....
Wooster	Owner	Owner	.....	.....
Zanesville	Owner	Owner	.....	Paved streets, thoroughly compact, concrete extend 6" beyond trench
Oklahoma:				
Muskogee	City or owner	City	$10 for pav't, cost for dirt	Both flush and tamp
Norman	Owner	Owner	....	None
Shawnee	City	City	$5 per sq. yd.	Tamp in 6" layers
Tulsa	Owner	Owner	Cost plus 20%	Five-year maintenance under pav'ts
Wagoner	Owner	City	Cost	Flush and tamp
Oregon:				
Astoria	Owner	City	.....	Tamp or flood under instruction
Dallas	Owner	Owner	.....	Water tamp
Eugene	Owner	City	Cost	City direction
Oregon City	Owner	Owner	.....	First class job
Portland	Owner	City	Total cost plus 10%	Use water and tamp well
Salem	Owner	City	Actual cost	Tamp and puddle
Pennsylvania:				
Allentown	Owner	Owner	Cost plus 10%	Two tamping to 1 shovelling; puddling prohibited
Altoona	Owner	City	Actual cost	.....
Bangor	Owner	Owner	$1 plus cost of supervision	Supervision of borough engineer
Berwick	Owner	Borough	Cost plus 20%	Maintain for 30 days
Blairsville	Owner	Owner	Actual cost	None
Bradford	City	City	Entire cost	Tamp in 6" courses
Butler	Owner	City	Cost	As good condition as found
Catasauqua	Owner	Boro, by contract	Cost	.....
Chambersburg	Owner	Borough	Cost	Thoroughly tamp, settle two months
Clairton	Owner	Owner	.....	Tamp, flush, concrete 12" wider than hole reinforced with ½" rods spaced 6"
College Hill	Owner	Owner	Cost	Puddle and tamp; under pavement, top 12" filled with gravel or coarse cinder and 2" of sand
Connellsville	Owner	Owner	Cost	"Carefully"; 6" concrete extend 6" on sides
Dale	Owner	Owner	.....	Ram solid, 6" concrete extend 6" on sides
Duquesne	Owner	Owner	.....	None
Easton	Owner	City	.....	Adequate tamping, solid to street level
Ellwood City	Owner	Borough	Actual cost	Direction of borough engineer
Farrell	Owner	Borough	Entire cost	.....
Franklin	City	City	Cost	.....
Freeland	City if pav., owner otherwise	City	$6 per sq. yd.	.....
Greensburg	City	City	Cost	Thoroughly tamped; 8 in. concrete extends 9 in. beyond trench
Greenville	Owner	City	Cost plus 20%	Flushed in warm weather; dry if cold
Grove City	Owner	Borough	Cost plus 10%	If paved, 6 in. reinforced slab extending 18 in. beyond trench
Hanover	Owner	Borough	$4 per sq. yd. if paved	None
Harrisburg	Owner	City	$3.50 for asphalt	None
Hazleton	Owner	City	Cost	.....
Indiana	Owner	Owner	.....	Good shape as originally—Never is
Jersey Shore	Owner	Borough	.....	Tamp in 4 in. layers
Lebanon	Owner	City	Cost	None
Meadville	Owner	City	.....	Maintain until pavement is laid
Monongahela	City	City	Cost plus $2	Ram thoroly; 6 in. concrete extends 12 in. beyond trench; reinforced if trench more than 3 ft. wide
Munhall	Owner	Owner	.....	None
Nazareth	Owner	Borough	Asph. conc., $2.70; macadam, $1.35; gravel .45	None
New Brighton	Owner	Borough	Cost	Tamp well or wet
Norristown	Owner	Owner	.....	Ram, construct concrete arch extending 6 in. beyond trench, lay 6 in. concrete base on this
North East	Owner	City	Cost	None
Oil City	Owner	City	Cost plus 15%	None
Pittston	Owner	City	$10 per sq. yd.	None
Rankin	Owner	City	Actual cost	None
Reading	Owner	City	Cost	.....
Reynoldsville	Owner	....	Total cost	Tamp with water
Sayre	Owner	Borough	Cost	.....
Scranton	Owner	City	$3.75 per sq. yd., $4.50 if less than 10 sq. yd.	Tamp in 12-in. layers
Sewickley	Owner	City	Cost plus 10%	New conc. extend 6-in. beyond trench
Sharon	Owner	City	Actual cost	Thoroughly tamp.
Sharpsville	Borough	Borough	.....	.....
Somerset	Borough	Borough	.....	Thoroughly soaked during filling
Throop	Owner	Borough	None	Flush
Tyrone	City	City	Cost	Thoroughly wet and damp.
Waynesboro	Owner	City	Cost	.....
Wilkes-Barre	Owner	City	Asph. $5 per sq. yd., brick $4.50, earth 20c.	.....
Williamsport	Owner	City	$7 per sq. yd.	New conc. extend 6-in. beyond trench
Woodlawn	Owner	Owner	.....	Instructions of street commissioner
York	Owner	Owner	Actual cost plus 10%	.....
Rhode Island:				
Cranston	Owner	City	Macadam $1.50, penetration $3, asphalt $8.15	None
Pawtucket	Owner	City	.....	None
Providence	Owner	Owner or city	Cost	Return street to original condition
Woonsocket	Owner	City	Cost	.....
South Carolina:				
Charleston	City	City	Fill, 40 to 80c per cu. yd.	Tamp in 6-in. layers
Chester	Owner	City	Cost	City engineer's instructions
Florence	Owner	Owner	.....	Replace as before
Greenville	Owner	City	$15 for 1st yd., $10 for each additional	Hand or water tamped

City.	Who Backfills Street Trenches?	Who Replaces Pavement Over Trenches?	What Charge Does City Make?	Special Regulations for Backfilling.
South Carolina (Continued)				
Orangeburg	City	City	Actual cost	Tamp.
South Dakota:				
Mitchell	Owner	City	.....	Tamp in layers, flush, allow to settle
Sioux Falls.....	Owner	City	$3 per sq. yd.	Tamp or flush
Tennessee:				
Alcoa City.....	City	City	Actual cost	Tamp in thin layers
Clarksville	Owner	City	Cost	Tamp.
Cleveland	Owner	City	Actual cost	Water tamp
Dyersburg	Owner	City	.....	Fill by hand
Jackson	Owner	City	Actual cost	Supervision of city engineer
Trenton	Owner	Owner	.....	Replace in original condition
Texas:				
Amarillo	Owner	City	Cost	If paved, fill with gravel
Ballinger	Owner	Owner	.....	None
Bonham	Owner	.....	.....	Lower part puddled, upper tamped
Cleburne	Owner	Owner	.....	Satisfy city engineer
Corpus Christi....	Owner	City	Cost	None
Dallas	.....	City	.....	Tamp and flush under inspection
Denton	Owner	City	None	Supervision of city engineer
Eastland	City	City	Cost	Puddle or fill with sand or gravel
Mexia	Owner	City	.....	Flush and tamp
Mineral Wells.....	City	City	$2 per lin. ft.	.....
Paris	City	City	Actual cost	City does first-class job
San Angelo .....If paved, city; otherwise owner		City	Cost plus 10%	Direction of city engineer
San Benito.....	Owner	Owner	.....	Return all material excavated
Weatherford	Owner	City	$5 per sq. yd.	Dump or use scrapers
Utah:				
Brigham	City	City	None	Wet down and tamp
Logan	Owner	Owner	Actual cost	Tamp and flush
Ogden	Owner	Owner	.....	None
Provo	Owner	Owner	.....	Puddle and ram
Salt Lake.....	Owner	City	$8.55 per sq. yd.	Moisten and tamp in layers
Tooele	Owner	City	None	Tamp in 6-in. layers
Vermont:				
Barre	City	City	.....	Leave surface as good as original
Bennington	City	City	.....	.....
Rutland	City	City	Actual cost	One tamp to 2 shovels, 12-in. layers
Virginia:				
Danville	City	City	Cost	Pav't not opened before 3 years old
Washington:				
Aberdeen	Owner	Owner	Cost	.....
Dayton	City	City	Cost	.....
Mount Vernon....	Owner	City	Cost	Tamp or flush
Puyallup	Owner	City	.....	Tamp by hand around & 1 ft. above pipe
Yakima	Owner	City	$3.50 per sq. yd.	Thoroughly water settle
West Virginia:				
Bluefield	City	City	Actual cost	None
Charleston	Owner	Owner	.....	Replace, good condition as original
Clarksburg	Owner	Owner	.....	None
Fairmont	Owner	City	.....	.....
Wisconsin:				
Delavan	Owner	City	Total cost	Under direct supervision
Eau Claire	City	City	Cost	None
Janesville	Owner or city	Owner or city	Cost	None
Kaukauna	Owner	Owner	.....	Under city inspection
La Crosse	City	City	Cost plus 20%	.....
Manitowoc	Owner	City	.....	Tamp or puddle; 3" mound allowed
Marinette.....	Owner	Owner	.....	Restore in good condition as found
Menomonie.....	Owner	Owner	.....	Use water
Norwalk	Owner	Village	.....	None
Ripon	Owner	Owner	Cost plus 10%	Puddle in sand or gravel, tamp elsewhere
Stevens Point.....	City	Contractor	.....	Water tamp—soil is sandy
Tomahawk	Owner	.....	.....	Refill in same condition
Waukeshaw	Owner	City	$20 per opening	Tamp in 9-in. layers
Wausau	Owner or city	Owner	Actual cost	Puddle and tamp
Wisconsin Rapids.City, if paved, otherwise owner		City	Cost	Leave in as good condition as found
Wyoming:				
Casper	Owner	City	$4 per sq. yd.	Tamp, sprinkle if necessary; refill with gravel where necessary
Sheridan	Owner	City	.....	Either hand tamp or settle with water

(Continued from page 58)

Bacterial removals were about what would be expected. The definitely higher removals recorded by the normal process indicate with clearness the sterilizing effect of the nascent oxygen released in the electrolyzer. The evidence to this effect is unmistakable, and the almost total destruction of the delicate Bascillus coli is just what would be expected in this connection.

Regardless of any standards hitherto promulgated, tentatively or otherwise, limiting the amount of dissolved organic matter in a given sewage effluent which safely may be discharged into a stream without creating a nuisance therein, the fact remains that with the normal process the final effluent remained *and without putrefactive odor* for at least three times the period true of the effluents of the excess lime method. In other words, by the methylene blue test the color was discharged in samples of the latter in two and one-half days' incubation at 20 deg. C. as compared with seven days (plus) for the former.

It has been repeatedly demonstrated that sewage clarified with lime will putrefy on mixing with river water, even if fairly sterile when discharged. The same phenomenon was observed during tests at Allentown. Where excess lime treatment reduced the dissolved organic nitrogen from 18 to 10.4 parts per million, this effluent, mixed with four volumes of river water, absorbed 6.5 parts of dissolved oxygen in five days' incubation in an open container at 30 deg. C. This was a representative result. On the other hand, with the normal method of operation, and with eight parts per million of dissolved organic matter in the effluent, this effluent, mixed with four volumes of river water, absorbed two parts per million of dissolved oxygen in five days' incubation in an open container at 30 deg. C. This also was a representative result.

The writer has always believed that the unusual stability of Direct Oxidation process effluents is in a large measure due to the actual wet combustion of perhaps immeasurable quantities of the most putrescible of the organic matters in the sewage. The result of the Allentown tests seem to resolve this supposition into a fact of considerable reliability.

Since this test was made, mechanical improvements have been made in the plant, but no changes in the theory or details of operation.

STONE BLOCK AND BRICK PAVEMENT LAID IN 1922

Name of City.	Area in sq. yds.	Cost, total or per sq. yd.	Area in sq. yds.	Cost, total or per sq. yd.
Alabama:				
Birmingham	2,646	$13,721.00	15,327	$60,583.00
Connecticut:				
Bridgeport	1,600	6,400.00[c]	.....	.....
New Haven	.....	.....	2,764	6,000[l]
Willimantic	1,900	9,991.00	.....	.....
Delaware:				
Wilmington	17,964[a]	4.16[d]	13,400	4.75[d]
Florida:				
Tallahassee	.....	.....	12,000	2.50
Illinois:				
Chicago	3,171	.....	136,889	.....
Danville	.....	.....	25,000	3.30[b]
Decatur	.....	.....	23,482	98,395.00[k]
DeKalb	.....	.....	7,000	27,000.00[f]
Joliet	.....	.....	17,100	.....
Macomb	.....	.....	14 city blocks	3.40[b]
Marion	.....	.....	1,100	3.96[b]
Mattoon	.....	.....	22,000	3.25[b]
Moline	.....	.....	18,000	Br. flat 2.28[l] Br. edge 2.73
Ottawa	.....	.....	25,000	3.40[b]
Quincy	.....	.....	29,320	113,900.00[d]
Waukegan	.....	.....	1,250	5,900.00[l]
Indiana:				
Bedford	.....	.....	4,200	3.70
Decatur	.....	.....	1,420	4.00
Elwood	.....	.....	1,584[a]	.....
Fort Wayne	.....	.....	8,487	40,737.00[l]
Plymouth	.....	.....	17,000	2.64
South Bend	.....	.....	867	3,169.00[t]
Winchester	.....	.....	2,400	3.50
Iowa:				
Cedar Rapids	.....	.....	26,353	95,743.00[k]
Keokuk	.....	.....	1,584	3.23[c]
Muscatine	.....	.....	25,487	110,210.00[k]
Ottumwa	.....	.....	17,000	3.92
Kansas:				
Atchison	.....	.....	2,000	3.48
Ft. Scott	.....	.....	60,000	2.90[b]
Independence	.....	.....	7,000	2.85[b]
Salina	.....	.....	55,400	215,000.00[b]
Wichita	.....	.....	26,964	128,856.00[k]
Kentucky:				
Ashland	.....	.....[l]	3,800	5.35[b]
Maine:				
Bangor	1,981[a]	3.39[c]	.....	.....
Portland	9,060	.....	2,022	.....
Rockland	.....	.....	1,147	4,197.00
Massachusetts:				
Brockton	224	2.50[c]	.....	.....
Brookline	.....	.....	1,062	4.03
Fitchburg	10,500	4.10	.....	.....
Lowell	22,933	.....	.....	.....
New Bedford	3,973	8.20[c]	.....	.....
Pittsfield	.....	.....	12,343	4.75[c]
Worcester	3,154[a] relaid 2,040 new	5.50[a] 7.50[c]	.....	.....

Name of City.	Stone-Block: Area in sq. yds.	Stone-Block: Cost, total or per sq. yd.	Brick: Area in sq. yds.	Brick: Cost, total or per sq. yd.
Oklahoma:				
Muskogee	.....	.....	3,800	$4.20[a] 3.90
Pennsylvania:				
Allentown	.....	.....	1,342	5,766.00[c]
Altoona	.....	.....	37,295	126,450.00[d]
Bradford	.....	.....	29,905	151,000.00[f]
Butler	.....	.....	10,450	2.95[b]
Clairton	.....	.....	9,158	3.50[b]
Ellwood City	.....	.....	2,300	3.37
Farrell	.....	.....	7,638	18,200.00[c]
Franklin	.....	.....	11,544	2.15
Greensburg	.....	.....	2,787	3.04[c]
Greenville	.....	.....	8,500	31,800.00[l]
Grove City	.....	.....	2,000	3.10[b]
Hazelton	.....	.....	912	4,251.00[d]
Jersey Shore	.....	.....	952	3.15[d]
Meadville	.....	.....	20,000	3.42[c]
Monongahela	.....	.....	14,210	60,308.00[d]
North East	.....	.....	8,000	41,403.00
Oil City	.....	.....	8,834	2.47[a]
Parkesburg	.....	.....	666	.....
Scranton	2,005	8.00[c]	.....	.....
Sewickley	.....	.....	5,184	1.28½[v]
Sharon	.....	.....	3,850	17,826.00[l]
Throop	.....	.....	2,500	7.00
Williamsport	.....	.....	1.35 mi.	3.50[c]
York	.....	.....	426	1,920.00
Rhode Island:				
Providence	17,587	5.55[b]	.....	.....
Woonsocket	3,800	$4.20[a]	.....	.....
Texas:				
Amarillo	.....	.....	101,000	410,000.00
Virginia:				
Danville	6,636	6,375.00[c]	.....	.....
West Virginia:				
Charleston	.....	.....	17,321	.....
Clarksburg	.....	.....	19,800	118,800.00[f]
Fairmont	.....	.....	2,880	8,776.00[c]
Wisconsin:				
Wisconsin Rapids	.....	.....	6,500	3.82[b]

[a]—Surface only. [b]—Surface and base. [c]—Surface, base and grading. [d]—Surface, base, grading and curb. [e]—Surface, base, grading, sewer adjustments. [f]—Surface, base, grading, curb, drainage. [g]—Surface, curb and gutter. [h]—Surface, base, grading, curb and gutter. [i]—Entire improvement. [k]—Entire improvement, including engineering, inspection, etc. [l]—Top only; 6" base cost $1.40. [m]—$6.60 for N. Y. speci. on 8" concrete base; $2.65 for old blocks on 8" base (formerly on sand) plus $13 per M. for recutting. [n]—3" brick on 7" base, $4.20; on 6" base, $3.90. [r]—Resurfacing over old pavement. [s]—Relaid. [t]—Surface, base, grading and drainage. [u]—Surface, base, grading, curb, storm sewer and catch-basins. [v]—Repaving on old base.

SHEET ASPHALT AND ASPHALT CONCRETE LAID IN 1922

Name of City	Sheet Asphalt: Area, Sq. Yds.	Sheet Asphalt: Cost	Asphalt Concrete: Area, Sq. Yds.	Asphalt Concrete: Cost
Alabama:				
Birmingham	17,254	$41,127.00	101,707	$225,187.00

Michigan:				
Ann Arbor	.....	.....	3,423	3.79[b]
Benton Harbor	.....	.....	40,000	2.20
Grand Rapids	.....	.....	1.1 mi.	90,000.00[k]
Kalamazoo	.....	.....	6,927	24,977.00[c]
Mt. Clemens	.....	.....	100	4.00[b]
Niles	.....	.....	1,300	6,200.00[b]
Minnesota:				
Mankato	.....	.....	23,827	3.53[b]
Minneapolis	17,617	88,085[c]	35,185	174,140[c]
Mississippi:				
Hattiesburg	.....	.....	25,500	81,600.00[c]
McComb	.....	.....	23,511	3.81[b]
Missouri:				
Kansas City	.....	.....	1.19 mi.	67,200[b]
St. Louis	46,880	252,485.00[d]	71,735	413,939.00[d]
Nebraska:				
Omaha	.....	.....	57,932	218,266.00[c]
New Hampshire:				
Nashua	17,348[s]	.88[s]	.....	.....
New Jersey:				
Camden	1.67 mi.	6.60[m]	.....	.....
		2.65		
Newark	2,770	37,700.00[d]	.....	.....
Plainfield	15,400	73,750.00	.....	.....
Rutherford	.....	.....	100	6.25[c]
Trenton	16,000	.....	2,300	.....
New York:				
Buffalo	4,026	.....	9,051	49,222.00
Cohoes	12,655	5.00[f]	.....	.....
Cortland	.....	.....	1,000	4.00[d]
Endicott	.....	.....	8,000	4.96[c]
Fulton	200	7.50	.....	.....
Jamestown	.....	.....	39,792	.....
Johnson City	.....	.....	5,256	24,010.00
Lackawanna	.....	.....	8,850	47,785.00[f]
New York—Manhattan	45,000	7.20[c]	.....	.....
Niagara Falls	.....	.....	11,310	296,196.00[d]
N. Tonawanda	.....	.....	2,361	12,102.00
Olean	.....	.....	3,560	4.00
Rochester	4,000	1.61[b]	1,500	4.06[b]
North Carolina:				
Durham	.....	.....	6,900	3.86[b]
North Dakota:				
Fargo	.....	.....	590	5.65[b]
Ohio:				
Akron	.....	.....	2.96 mi.	3.41[b]
Alliance	.....	.....	2,700	15,000.00[b]
Ashtabula	.....	.....	21,255	5.60[m]
Belleview	.....	.....	2,158	11,200.00
Bucyrus	.....	.....	11,000	42,000.00[d]
Chillicothe	.....	.....	10,800	23,300.00[c]
Cincinnati	105,130	5.28[c]	1,285	2.65[e]
Columbus	18,000	112,000.00[d]	35,000	182,000.00[d]
Dayton	1,258	6,016.00[c]	36,351	174,020.00[c]
E. Youngstown	.....	.....	8,360	34,680.00[d]
Elyria	.....	.....	2,410	17,305.00[f]
Findlay	.....	.....	12,063	2.30[d]
Ironton	.....	.....	33,000	2.62[b]
Lancaster	.....	.....	20,700	53,471.00[d]
Warren	.....	.....	71,600	427,296.00[d]
Wooster	.....	.....	2,600	3.23[b]
Zanesville	.....	.....	4,406	14,311.00[d]

California:				
Monterey	.....	.....	35,000 ft.	0.33
Oakland	.....	.....	1.082 mi.	95,700.00
Santa Barbara	26,603	2.34	21,756	2.43
Santa Rosa	.....	.....	11,111	1.26
Vallejo	.....	.....	4,300	1.80[c]
Visalia	.....	.....	42,873	139,946.00[d]
Connecticut:				
Bridgeport	12,500[m]	35,000.00	.....	.....
Hartford	2,521	10,261[t]	.....	.....
Middletown	36,279	136,500.00[t]	.....	.....
New Haven	12,877	32,800[d]	5,763	13,600[d]
Delaware:				
Wilmington	89,213	2.96[k]	.....	.....
District of Columbia:				
Washington	24,500	3.16	.....	.....
Illinois:				
Centralia	.....	.....	39,000	.....
Chicago	775,893	.....	.....	.....
Danville	40,000[a]	2.35	.....	.....
Decatur	49,187[m]	135,666.00[b]	.....	.....
DeKalb	.....	.....	18,000	43,000.00[a]
Joliet	.....	.....	74,700[c]	422,000.00[d]
East St. Louis	26,500	100,000.00[h]	.....	.....
	6,800	48,000.00[k]	.....	.....
Moline	.....	.....	60,505	2.60[e]
Oak Park	50,261	364,526.00[f]	.....	.....
Quincy	52,060	214,000.00[k]	.....	.....
Riverside	.....	.....	37,800	90,137.00
Indiana:				
Boonville	26,000	3.42[d]	.....	.....
Fort Wayne	24,189	112,955.00[d]	73,529	272,772.00[d]
Huntington	11,851	32,751.00[k]	.....	.....
	6,210[m]	9,935.00	.....	.....
Peru	4,890	58,882.00[n]	.....	.....
South Bend	3,168	22,601.00[n]	63,755	178,229.00[n]
Terre Haute	12,966	50,100.00[k]	.....	.....
Winchester	.....	.....	8,000	1.69[o]-2.24[d]
Iowa:				
Cedar Rapids	.....	.....	1,934	4,647.00[d]
Fort Dodge	8,100	2.34[g]	35,000	2.69[g]
Oskaloosa	40,000[m]	1.42	.....	.....
Kansas:				
Paola	.....	.....	5,401	19,542.00[d]
Wichita	8,041	23,371.00[d]	7,914	56,106.00[d]
Kentucky				
Lexington	3,900	22,800.00[n]	9,700[p]	28,000.00[n]
	.....	.....	14,500[g]	79,000.00[n]
Massachusetts:				
Brockton	.....	.....	822	2.10[t]
Lowell	8,745	.....	9,464	.....
New Bedford	13,601[h]	1.80	.....	.....
Waltham	.....	.....	20,895	2.70[t]
Worcester	38,020	1.80[s]	.....	.....
Michigan:				
Ann Arbor	22,370	2.51[b]	.....	.....
Detroit	716,180	3,188,418.00[k]	.....	.....
Grand Rapids	1.55 mi.	791,000.00[d]	.....	.....
Holland	19,600	53,325.00[d]	.....	.....
Iron Mountain	.....	.....	11,444[m]	43,560.00[r]
Kalamazoo	73,508	183,903.00[e]	.....	.....
Pontiac	11,150	1.60[b]	26,000	1.10[h]
Saginaw	95,135	3.82[d]	.....	.....
Sturgis	81,000	2.21[e]	.....	.....

SHEET ASPHALT AND ASPHALT CONCRETE LAID IN 1922—Continued

Name of City	Sheet Asphalt Area, Sq. Yds.	Sheet Asphalt Cost	Asphalt Concrete Area, Sq. Yds.	Asphalt Concrete Cost
Minnesota:				
Duluth	34,000	4.07[o]	.....	.....
Minneapolis	.....	.....	164,227	594,605[t]
Missouri:				
Kansas City	3.11 mi.	167,777[o]	.....	.....
Marshall	.....	.....	18,000[m]	1.87
St. Joseph	27,893	.....	24,675	.....
St. Louis	70,210	262,525.00[k]	5,365	24,920.00[k]
Nebraska:				
Chadron	.....	.....	72,000	2.78[o]
Grand Island	15,800	2.54[o]	.....	.....
Lincoln	119,030	2.37[t]	49,443	2.57[t]
North Platte	154,300	498,902.00[d]	.....	.....
Omaha	63,800	139,660.00[t]	403,432	1,051,008.00[t]
Scottsbluff	5,800	.....	.....	.....
New Hampshire:				
Berlin	.....	.....	11,202	2.50
Nashua	.....	.....	18,818	.67[t]
New Jersey:				
Bridgeton	.....	.....	35,000	2.00[o]
Camden	7.85 mi.	3.02[u]	.....	.....
Clifton	45,000	3.00[d]	.....	.....
Newark	131,592	363,526.00[k]	36,076	125,044.00[k]
New Brunswick	45,737	174,546.00[k]	.....	.....
Plainfield	46,240	156,000.00[t]	.....	.....
Trenton	60,000 yd.	.....	.....	.....
Wallington	9,607	29,974.00	.....	.....
New Mexico:				
Albuquerque	.....	.....	80,000	240,000.00
New York:				
Buffalo	183,467	902,161.00[d]	.....	.....
Cortland	.....	.....	38,000	1.20 to 1.55[b]
Fulton	.....	.....	47,000	2.30[o]
Geneva	17,000	118,000.00[o]	.....	.....
New York-Manhattan	196,000	2.80[t]	.....	.....
Niagara Falls	27,283	171,133.00[d]	.....	.....
Rochester	247,340	2.93[o]	.....	.....
	93,245	1.79[b]		
Schenectady	53,537.28	194,214.00[b]	.....	.....
	36,992.24	166,066.00[k]		
North Carolina:				
Ashville	43,133	3.63[o]	.....	.....
	10,000	1.62[b]		
Charlotte	241,023	650,000.00[t]	.....	.....
Durham	38,000	3.27[o]	.....	.....
Greensboro	95,000	1.26 to 1.65[b]	9,000	1.15[b]
North Dakota:				
Fargo	13,400	3.60[o]	.....	.....
Ohio:				
Akron	5.44 mi.	2.97[o]	.....	.....
	0.17 mi.	4.20[n]		
Columbus	200,000	810,000.00[d]	.....	.....
Dayton	17,077	105,510.00[t]	.....	.....
Elyria	14,300	68,145.00[n]	8,320	16,000.00[n]
Findlay	51,944	3.55[v]	25,542	3.40[v]
	62,146	2.35[b]		
Lakewood	25,540	151,312.00[n]	228,057	601,697.00[n]
Marion	8,011	41,200.00[k]	.....	.....
Middletown	99,057	277,396.00[t]	.....	.....
Newark	13,571	47,853.00[d]	.....	.....
Warren	2,470	8,684.00[d]	.....	.....
Washington	4,200	3.15	.....	.....
Wilmington	25,066	77,000.00	.....	.....

Name of City	Sheet Asphalt Area, Sq. Yds.	Sheet Asphalt Cost	Asphalt Concrete Area, Sq. Yds.	Asphalt Concrete Cost
Oklahoma:				
Muskogee	9,250 yd.	1.14[b]	.....	.....
Tulsa	.....	.....	55,493	6.50[b]
Oregon:				
Portland	.....	.....	22,827	41,817[d]
Salem	.....	.....	5,676	.....
Pennsylvania:				
Allentown	4,495	14,852.00[t]	.....	.....
Farrell	1,794	6,081.00[o]	.....	.....
Greenville	9,000	1.50[b]	.....	.....
Grove City	15,000	3.10	.....	.....
Harrisburg	56,831	175,000.00[t]	.....	.....
Oil City	22,781	.84[b]	.....	.....
Reading	20,897	67,798.00[t]	.....	.....
Scranton	51,254	3.25[t]	.....	.....
Sharon	New 12,600	57,972.00[k]	.....	.....
	Resurf 7,520	15,435.00[b]		
Throop	5,000 yd.	5.25	.....	.....
Wilkes-Barre	26,853	144,708.00[d]	.....	.....
Williamsport	1.74 mi.	3.25[t]	.....	.....
York	25,699	85,293.00[w]	.....	.....
Rhode Island:				
Cranston	.....	.....	14,200	1.41[b]
Providence	59,949	3.00-3.44[o]	.....	.....
South Carolina:				
Charleston	98,736	.89[b]	.....	.....
Greenville	2,330	4,200.00[b]	18,149	45,373.00[t]
Orangeburg	8,535	2.04	94,380	1.92
Tennessee:				
Cleveland	.....	.....	37,600	122,500.00[d]
Dyersburg	15,000	45,000.00	.....	.....
Murfreesboro	16,000	1.15	.....	.....
Utah:				
Salt Lake	.....	.....	20,000	1.90[w]
Virginia:				
Danville	43,186	58,282.00[b]	39,090	108,034.00[t]
Washington:				
Yakima	.....	.....	42,373	97,794.00[w]
West Virginia:				
Bluefield	45,000	180,000.00[k]	.....	.....
Charleston	22,641	.....	120,317	.....
Wisconsin:				
Stevens Point	.....	.....	20,000	2.66[b]

[a]—2-inch native sheet asphalt top, 1-inch close binder, resurface over brick. [b]—Wearing surface, excav., curb, catch basins, drainage, overhead. [c]—Includes 17,000 sq. yd. vertical fibre 3-inch and hillside brick. [d]—Entire improvement. [e]—$1.20 sq. yd. 5-inch base; 40c 1-inch binder; $1.00 1½-inch top. [f]—Includes wearing surface, base, grade, sewer adjustments. [g]—2-inch wearing surface on 5-inch concrete; curb, 6x20 inch 89c per ft. [h]—Top only. [k]—Surface, binder, base, curb, grading. [l]—Wearing surface, base and grading. [m]—Surface, base, grading, curb, drainage. [o]—Surface and base. [p]—Macadam base. [q]—Concrete base. [r]—Surface, curb and gutter. [s]—Laid on old macadam. [t]—Surface, grading, and catch basins. [u]—Surface, base, grading, curb and catch basins. [v]—Surface, base and curb. [w]—Surface, base and gutters.

PUBLIC WORKS.

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A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

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Developments in Earth Excavation

By Geo. B. Massey, M. Am. Soc. C. E.*

Modern machinery saves labor, eliminates operating delays, and can be obtained of any desired capacity, for heavy or light excavation, trenches, etc. Hydraulic excavators. Draglines. Internal combustion engines for power.

It does not seem as though men could go on year after year improving the methods of handling dirt. But they do. And these improvements, which originate for the most part in this country, are immediately investigated and adopted abroad.

STEAM-SHOVEL WORK.

A few years ago most of the heavy earth excavation was made by the standard two-track, railroad type of steam shovel, running on short sections of standard gauge track and loading dump cars which were hauled by steam locomotives to a dump. Here the cars were dumped by hand, and a large force of men dug away and pushed the dumped material over the edge of the dump and then worried the track over to the edge.

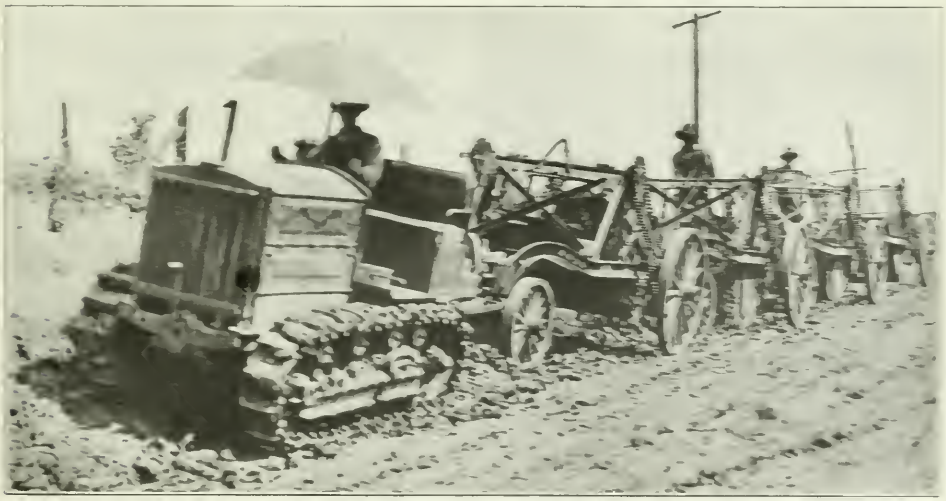
Around the shovel were the gunmen who brought up the track sections, laid them and connected them up, placing rail clamps and handling the jack-screw jacks in moving ahead. It required from four to six men.

Now if a standard railroad type of shovel is used, it is mounted on caterpillar traction and therefore requires no gunmen or jacks, the moving up being handled entirely by the shovel runner.

This eliminates four to six men in earth excavation.

The locomotives, if not large, are very apt to be driven by gasoline engines and a logical further development will be locomotives driven by heavy oil engines.

The cars, if not too small, are dumped by air and the dumped material is strained to the edge and over



TRACTOR HAULING FOUR-WHEEL SCRAPERS

*Member Randolph-Perkins Co. Engineers. Author of "Engineering of Excavation."

the edge of the dump by a very powerful, all-steel spreader plow which will maintain a level top along the dump up to twenty-three feet in width so that the track moving has to be done very seldom and then is done with a track-shifting machine.

Thus are eliminated pitmen about the shovel, delays due to moving up, delays for coaling the engine, men to dump the cars and the large force necessary to prepare the dump for dumping further trainloads.

As a matter of fact, the railroad type of shovel has long been largely superseded by the revolving shovel which is built to carry dippers running all the way from one-half cubic yard to seven or eight cubic yards, with no mechanical reason why they cannot be increased considerably above that.

The advantages possessed by the revolving shovel is that it can dig anywhere and dump anywhere in the circle and therefore does not have to be run back for a new cut with loss of time.

The development therefore has been consistently along the following lines:

1. Eliminating common labor wherever possible.
2. Eliminating delays in operation.
3. Increasing the capacity of the machinery.

There has also been a very pronounced improvement in the revolving shovels in that they now can be altered in the field at very slight additional cost so as to become a dragline machine or a crane, a clamshell machine or a pile driver.

The use of gasoline or oil engines on these machines does away with the fireman and the use of caterpillar traction does away with the man on the ground to handle the pads. An improvement has been made recently in the operating levers, making it much easier on the runner.

Excavating problems are receiving more expert study than formerly, resulting in special methods being devised for individual cases, taking fullest advantage of local conditions.

USE OF WATER

Thus, where practicable, advantage is taken of the excavating and transporting possibilities of water.

HEAVY SPREADER PLOW FOR HEAVY EARTH FILL

Monitors are installed for excavating and centrifugal pumps for transporting the excavated material to the spoil area.

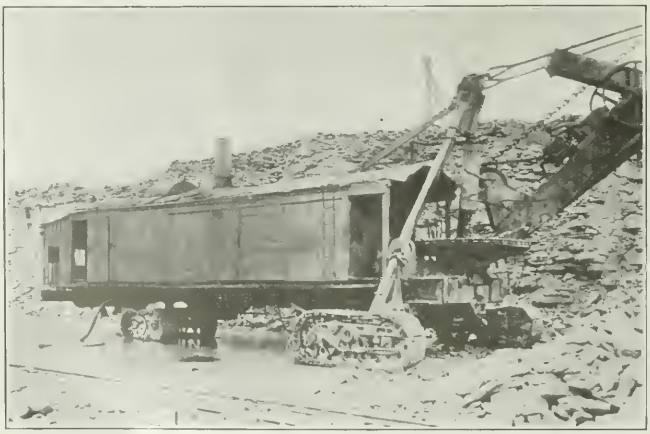
Or the earth is excavated by machinery and transported by water.

The writer made use recently of pressure water available near the work to move eighteen thousand yards four hundred feet, by means of a hydraulic elevator installed on a small barge, at a cost which worked out much less for equipment and operation than any method which could have been employed.

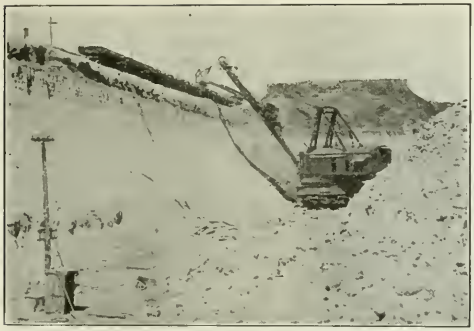
In this field, pumps are being improved and are being driven by oil engines. The quality and therefore the life of pipe has been improved.

A feature of interest developed by the Miami Conservancy District at Dayton, Ohio, was a white iron centrifugal pump shell. This result was obtained by chilling the casting in the mold after it had been poured, thus giving a very hard, white iron at the wearing surface and for a considerable distance back into the shell. A test of this pump shell showed that it had worn only one-fourth of an inch after pumping 110,000 cubic yards of sand and gravel. It was estimated that this meant a total pumping duty of 400,000 cubic yards for this shell. A grey iron shell had given a total life of 160,000 cubic yards and manganese steel shells from 134,000 to 182,000 cubic yards. The long life of the chilled cast iron shell was partly due to the design and partly to the fact that the cast iron can be cast in thicker sections than the manganese steel.

The Miami Conservancy District made considerable use of a stream of water flowing over the ground at a velocity sufficient to move earth, gravel and cobbles. This process is called sluicing and consists in so directing the stream of water that it will undercut a bank and then carry away the material which caves into the steam.



RAILROAD TYPE OF SHOVEL, FULL CATERPILLAR TRACTOR



ELECTRIC SHOVEL LIFTING TEN TONS THROUGH 65-FOOT ELEVATION

In breaking down banks with a hydraulic monitor, it often happens that the water required for the monitor is not enough to carry the broken down material through the centrifugal pumps and piping to the dam or spoil pile. Extra water at low pressure is supplied to the sump for this purpose and can be used to supplement the work of the monitors in breaking down material and carrying it to the sump. This makes possible carrying on the monitor operations at a greater distance from the sump than would be possible otherwise. Incidentally, it has been proved that the quickest and cheapest way to thaw frozen ground is to direct a stream of flowing water across the frozen area.

LIGHT EXCAVATION

Heretofore we have considered only bulk excavation. There are many cases where the work is of so little volume that it does not pay to use the customary types of excavating machines. In the old days, this called for teams and slip scrapers, the larger the work or the longer the haul, the greater the number of teams used.

At present there are two types of equipment which are used to the best advantage. Where the haul is not very long, four-wheel scrapers are hauled in a train by a caterpillar tractor. They are self-filled by men lowering the cutting edge into the work and are dumped by men at the fill or spoil pile.

For a longer haul, the excavating is done by an elevating grader hauled by a tractor, the grader loading trailers which are hauled by another tractor. Loading goes on while both tractors are in motion.

The advantage in the grader and trailers over the four-wheel scrapers is that the load pulled by the tractor is, in the case of the scrapers, the pull occasioned by loading the scrapers, while, in the case of the trailers, it is the pull required to move the trailers, which pull of course is less. Thus a larger amount of material can be transported by each tractor. The trailers spill less material than the scrapers and a shorter train will be required.

Where the cut is short, the scrapers have the advantage, as all of the scrapers can be loaded as each passes through the cut, while the grader continues in motion while loading trailer after trailer.

In skimming jobs, where the material is not carried away, but is deposited alongside the cut, a long-boom revolving shovel can often be used to advantage and will dispose of the material without transporting equipment being required. It will also leave a very good surface.

DRAGLINE MACHINES

A small dragline machine will have a longer working diameter from digging to dumping point and will leave a fairly good surface. The dragline machine has consistently increased in popularity since its introduction. By dragline machine is meant the revolving self-contained machine and not the so-called dragline machines which are better described as tower machines.

The dragline machine has so many advantages that it should have been developed years before it was. Its principal advantage is that it digs below the surface upon which it stands and dumps above the surface so that there is obtained a very high lift when compared with any form of shovel.

The second advantage is that none of the digging strains are transmitted to the boom, so that it can be made light and long, thus giving a long diameter from digging to dumping.

The body of the machine occupies a central position with regard to the vertical and also the horizontal movement of the load when both are extreme. This is an ideal condition.

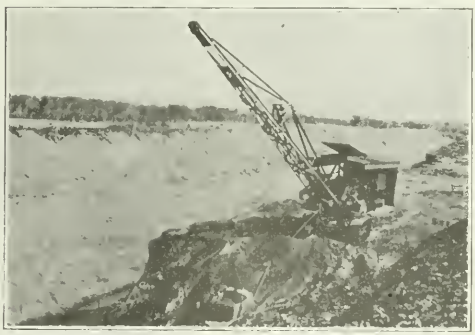
Draglines can work almost independently of drainage, as water does not affect the operation except in very light material.

Another advantage is that the dragline machine moves back away from its work and can maintain a suitable distance and a suitable slope between the machine and the cut to suit any class of material so as to obviate caving.

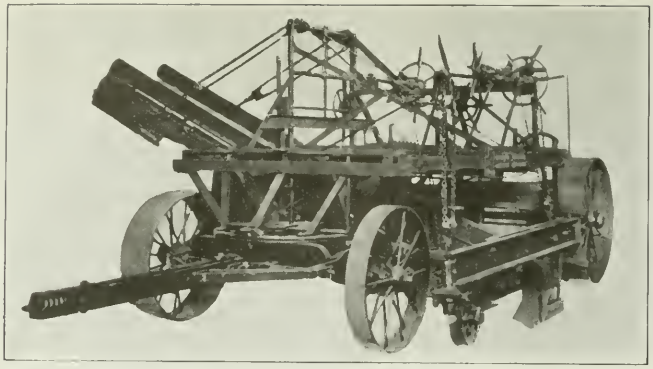
DIGGING TRENCHES AND CELLARS

In digging trenches for sewers or other pipe there has not been so much improvement as in other lines. The machines which survive are still the wheel type and ladder type with multiple buckets and also the small revolving shovel with long handle and special sewer bucket which is particularly effective in digging around buried pipe or other obstructions.

For cellar excavation, nothing has been found to be superior to the small revolving shovel. More and more of them are being used with a long boom, as the digging usually is fairly easy and it obviates



DRAGLINE MAKING A DEEP EXCAVATION
About 59,000 cubic yards removed from a channel 75 feet wide and 22 feet deep in 138 nine-hour shifts (two shifts per days) using a P. & H. No. 206 ¾-yard dragline



"WESTERN" EXCAVATOR AND LOADER

bringing the wagons or trucks into the excavation to load. Trucks are replacing wagons very largely. Small draglines have been used to some extent but they do not leave as good a bottom, do not swing so fast and do not dump as accurately. The shovel can dig more exactly to lines and leave fairly vertical walls.

All small shovels can, or should, climb out of an excavation on a very steep slope.

Most excavating machines are now mounted on caterpillars as the extra first cost has been proved to be offset many times by the reduced operating costs. The modern caterpillar is made up entirely of high-grade steel castings so that it can safely ride over or crush anything in its path.

Considerable effort is being made at present by engineers and builders in the application to excavating machines of internal combustion engines using the heavier grades of oil. The writer has designed a drive for an oil engine on a dipper dredge which is now being tried out. A great many obstacles have to be met and overcome in any design using a heavy oil engine for intermittent loads. An oil engine cannot be overloaded as a steam engine can, and cannot be allowed to stall, as is frequently the case with a steam engine.

The tower machines have a field in which they can operate very cheaply. This is in borrowing material over a large area and delivering it accurately placed at one spot, as is done in building levees along the Mississippi river. These machines handle seven or eight yards at a time over spans as high as six or seven hundred feet at an extremely low cost. The latest machines have both head tower and tail tower mounted on caterpillars. There is little control while digging, but extremely accurate control in dumping and the action of the bucket is such as to compact the material in the act of dumping.

The very large stripping and mining operations on the iron range and the low-grade copper properties, as also coal stripping and large quarry and gravel banks, are the most important examples of excavating and handling large quantities of material and the development here is universally in the adoption of the large revolving shovel operated by electricity.

In fact, steam plants on portable excavating machines are so notoriously expensive to operate, that electricity, gasoline engines or heavy oil engines are being installed in new equipment of all types and sizes.

Tunneling the Hudson River

Commuters and others travelling through the Metropolitan district in and around New York have become accustomed to underground travel and in fact the greater part of the local traffic is by underground routes. There is, therefore, nothing especially novel to them about crossing the Hudson river by tunnel rather than by ferryboats or bridge; in fact, they have been doing so for years. But the remarkable feature of the tunnel now under construction is that it is a vehicular tunnel, the first of the kind to be constructed in New York and vicinity.

So thoroughly sold, however, are the people and the capitalists of the city on the idea of

BUCYRUS TYPE OF TRENCH EXCAVATOR

the vehicular tunnel that already, now that the physical practicability and success of the first vehicular tunnel seems to be assured, two more are planned, one to cross the river opposite the upper part of the city, while the third tunnel is planned to be located between 23rd and 42nd streets, New York, to tap the heavy traffic from the middle of Manhattan Island. This tunnel is planned to be built with private capital and to reimburse the investors of the capital by the tolls collected, with the privilege of permitting the states to purchase it after five years, the tunnel to revert to the states after fifty years.

Wisconsin Highway Prices

Bids were received in February for several contracts for road work in Wisconsin totalling nearly $300,000. One of these was for a road in Walworth County, let to Fess & Fess at the following prices:

Earth excavation, 79c a cubic yard; loose rock $1.24; borrow 84c; ditching 85c; concrete surfacing $1.49 a square yard; cement in place 25c a barrel; Class A concrete in culverts $25 a cubic yard and in bridges $28 a cubic yard; storage of cement 10c a barrel; reinforcing steel in place 3½c a pound; total contract, $84,889.

Another road contract was let to R. R. Birdsall of Racine at the following prices: Earth excavation 99c a cubic yard; concrete surfacing $1.30 a square yard; cement in place 30c a barrel; concrete, Class A, in culverts $23 a cubic yard and in bridges $28; combination curb and gutter 50c a lineal foot; guard rail 60c a lineal foot; storage of cement 30c a barrel; steel reinforcing, in place, 4½c; 6-inch drain tile 25c a lineal foot; total contract, $113,210.

Garbage Disposal in Cleveland

The city of Cleveland has adopted its annual appropriation ordinance and in this we find that it anticipates for the year 1923 a revenue from the sale of garbage grease of $200,000, from the sale of tankage of $56,500, from the sale of waste paper $1,350 and from scavengers' privileges $1,920.

The receipt from garbage grease and tankage of $256,500 has a very attractive look, but turning to the appropriations we find that the budget allowance for garbage collection and disposal totals $1,087,107, or more than four times the receipts.

This total estimated expenditure comprises $795,621 for salaries and wages, $185,786 for supplies, $5,000 for maintenance of buildings and structures, $43,500 for maintenance of equipment, $51,200 for miscellaneous services, including $12,000 for insurance, taxes and rents, and $6,000 for new equipment.

Highway Work in New York

Reporting on conditions of highway contracts in New York State, Colonel Greene, the new highway commissioner, recently stated that there are in force 203 unfinished contracts for constructing and reconstructing 851 miles of roads, on which less than 35% had been paid for work performed up to March 1, 624 miles of pavement remaining to be laid. In addition, contracts had been let for 537 miles of pavement, which is 145 miles more than were built during the entire season of 1922. Of the contracts let in 1922 less than 105 miles have been completed and only 13 miles have been finally accepted. There are 88 miles of pavements still to be built on contracts carried over from 1921.

From these figures it would appear that New York State will do a good season's work if it completes the contracts already made without entering into any others this year.

A new section for concrete has been adopted by Commissioner Greene, having a parabolic top surface and a straight slope from each edge to center, with a thickness of 7 in. at the edges and 6 in. at the center. The weight of the reinforcing mesh is cut down to 40 pounds.

North Carolina's Highway Program

The 1923 highway construction program in North Carolina was put under way February 1 when bids were opened on over two hundred miles of road work. Plans for 1923 call for the awarding of approximately 800 miles of work.

Checking Grades in Steam Shovel Work

One of the problems for both engineers and steam shovel operators to get together on in any job is the placing and maintaining of grade stakes and securing of a fairly uniform grade by the shovel. The following suggestions for the shovel operator are given in the "Excavating Engineer":

When you start in on a cut you are ordinarily sure of your grade. It is only later that you might begin to be doubtful as to how you are holding it. When you have obtained your grade, therefore, thrust the dipper of your shovel out to the stops and drop it to the ground, then have someone measure with a string the length of rope you have out between the pin of your padlock and the center of your point sheave on the boom. Make note of this figure. It is obvious that if you are not keeping to this grade you can tell by measuring your rope again and comparing it with your first figure, providing you do it before you have moved up. If this figure is greater you are taking too much of a cut; if it is less you are taking too thin a cut.

It is not difficult for a shovel runner to work up a table of such figures for the usual grades, which will prove of great assistance to him in the future.

Another variation of this method is to tie a piece of string around the hoisting rope where it touches the sheave on the point of the boom. Any variation from your grade may be noted by watching this string and noticing its position relative to the sheave. These methods are both rough, but they are good.

Constructing Earth Dams in Vermont

Two dams, one two hundred feet high, built for the New England Power Co. with cores of fine material deposited by hydraulic method between embankments of earth brought in dump cars.

While dams built in the mountains of New England have probably, in the majority of cases, been of concrete or stone masonry, large earth dams are being built in Vermont by the Power Construction Company in developing hydro-electric power on the Deerfield river for the New England Power Company, of which it is a subsidiary. In fact, one of these dams which is now under construction, is one of the largest earth dams in the country, having a height of more than 400 feet above the bed of the stream and a maximum width at the bottom of about 1,500 feet.

THE SEARSBURG DEVELOPMENT

The Searsburg development consists of an earth dam across the Deerfield river west of Brattleboro, nearly four miles of wood stave conduit with a surge tank where this joins the steel penstock, and a power station. The river valley at the site of the dam is comparatively narrow and the banks have slopes as steep as 1:1 in some sections. The river has apparently changed its channel across the valley from time to time and the ground is found to consist largely of clay containing a number of large and small boulders. The east end of the dam connects with clay soil, but the west end abuts against a ledge which is utilized for constructing the intake and spillway in solid rock and for the location of a temporary by-pass.

The dam is 50 feet high at the highest point, 20 feet wide at the crest and about 240 feet at the lowest point. The earth section is about 200 feet long and the spillway about 350 feet. About 55,000 cubic yards of earth were required for the dam, which was obtained from borrow pits on the hills on the east end of the dam, at a higher level than the dam and about a quarter of a mile from it.

The chief feature of this construction that is in any way notable is the method of combining dry and hydraulic fill. Two dry embankments were carried up, one forming the downstream slope and the other the upstream, and between these a core of fine material was constructed by the hydraulic method.

The dry fill was made by dumping from two temporary trestles placed about 100 feet apart. These trestles were built of timber cut from the vicinity of the dam. The material, a mixture of clay and gravel, was excavated by a revolving steam shovel with a 1½-yard bucket which deposited it in 4-yard dump cars. These cars were handled on 30-inch gauge track by locomotives in two trains, which were able to handle the material as fast as it was excavated by steam shovel. The outer slopes of the two embankments were made 10 per cent. steeper than designed for the final slope in order to provide for future settlement.

When the fill had reached a height of about 15 feet the dry filling was discontinued and the ground surface between the two embankments was cleared, all boulders and river silt being removed down to hard pan, this forming a foundation for the watertight core. Depositing dry fill in embankment was then resumed, but the finer material deposited on the inner slopes was washed down into the middle of the dam by means of two fire streams that were operating continuously. As the fine material was washed down into the center between the embankments a pond was formed in which the material settled. The water was re-pumped from this pond into the lines of hose used for washing the fine clay from the sides of the embankments, a 2-stage electrically driven pump floating on a raft in the pond being used for this purpose. Additional water, of course, was required to make up for leakage from the pond, and a 6-inch single-stage pump supplied water from the river above the dam for this purpose. The hydraulic fill core obtained by this method was carried up only to

EXCAVATING EMBANKMENT MATERIAL, DAVIS BRIDGE DAM.

MAKING DRY FILL, DAVIS BRIDGE DAM.

the grade of the spillway, which was about 15 feet below the crest of the dam.

The hydraulic core was carried into a trench extending for some distance into the east bank of the river. To tie the core to the rock ledge at the west side, this ledge was cut to a vertical face and an abutment built against the face with buttresses or short core walls extending from the abutment into the hydraulic core to prevent leakage between the fill and the concrete abutment.

Preliminary to making the earth fill, a temporary bypass was made by blasting out a channel in the ledge on the west end of the dam behind the abutment. The upstream embankment dammed up the stream flow until it reached the elevation of this bypass, which carried the ordinary flow during the remaining construction of the dam.

This work was done by the Aberthaw Construction Company and was completed in the Fall of 1922.

"DAVIS BRIDGE DAM"

In the meantime the Power Construction Company had begun another development on the Deerfield river near Whitingham, which is considerably larger but will be carried on in much the same way; that is, by building two embankments, one at the upstream and the other at the downstream side, and then building an impervious core between these by hydraulic methods. This dam, known as the "Davis Bridge Dam," will be 204 feet high from the river bed to the crest, 1,500 feet in maximum width at the bottom, 25 feet wide at the crest and 2,000 feet long at the top. Nearly 2,000,000 cubic yards of material will be required for this dam. Work on this development was started April 23, 1922 and the contractor, W. F. Carey Company, Inc., has contracted to complete the work by the end of this year so that the spring freshets of 1924 may be impounded behind it.

The upstream slope of this dam is 3:1 for 100 feet below the crest, 3½:1 for the next 50 feet, and 4:1 for the remainder of the slope. On the downstream slope the top 100 feet is 2½:1, the next 50 feet 3:1 and the bottom 50 feet or more 3½:1.

As in the Searsburg development, dry embankments are being carried from one side of the valley to the other both above and below the middle of the structure, thus forming practically a cofferdam. The middle 300 feet of the dam will then be cleared of all boulders, stumps and loose material and a trench 50 feet wide and about 15 feet deep to hard clay bottom will be carried entirely across the valley and into the hills at the ends to receive the foot of the hydraulic fill core wall.

This core wall will be made in the same way as in the dam first described, by washing the fine clay from the inner slopes of the two embankments and allowing it to settle in the pool in the center of the dam. In this case it is intended to provide two pumps on pontoons for pumping water from this pond to the hose used in washing in the fine core material.

A diversion tunnel 1,500 feet long has been constructed by the Rollin Construction Company for carrying the river around the dam. Part of this tunnel will be used as a spillway.

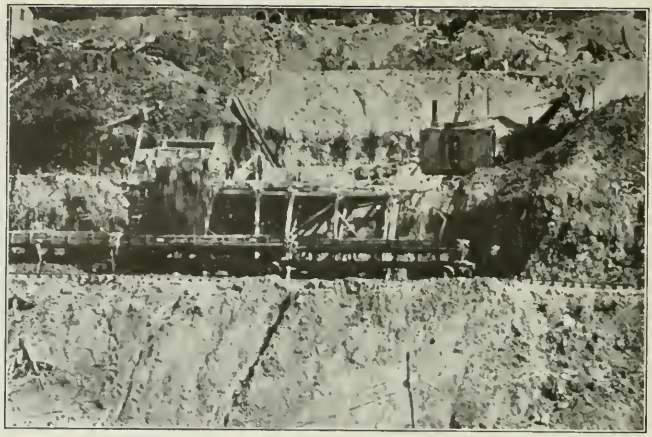
The river, after leaving the dam, winds around a mountain and the power house will be on the other side of this mountain and water will be

SITE OF DAVIS BRIDGE DAM, DECEMBER, 1922

led to it from above the dam by a tunnel through the mountain, which construction will add greatly to the available head. This tunnel was started last September.

One of the principal difficulties in constructing this dam is in finding the enormous amount of material required for building it in a country where the earth overburden is not ordinarily very deep. Some of the rock taken from the two tunnels is being used in the embankment. In addition to the rock, numerous boulders, both large and small, are found in the earth excavation.

Bucyrus steam shovels are used by the Carey Company, and last October a Bucyrus dragline, which had been used by that company in phophate operations in Florida, was brought up for this construction, having a 100-foot boom and a 3½-yard bucket. Most of the material excavated is dumped into standard-gauge dump cars manufactured by the Western Wheeled Scraper Company, which are hauled in trains by American locomotives and dumped, making the embankments for the dam. One interesting variation was noted in handling the rock from the penstock tunnel. This material last September was being loaded by a small steam shovel into 4-yard Western dump cars and these small cars were hauled by horsepower a short distance onto a temporary trestle built alongside of a standard gauge track at a lower level. Standard gauge cars were spotted in front of this trestle and the small cars were dumped into them. This was apparently more economical than carrying trains of small cars to the dump on special track or than carrying the standard gauge track fifteen or twenty feet higher up the hill by switchback and filling the large cars by a small shovel.



SMALL CARS DUMPING INTO LARGER ONES.

Cost of Excavating Sandstone

J. S. Walton, of Brandenburg, Kentucky, gives the following as actual costs, with no profit included, of taking out sandstone in a small road cut in Kentucky where the nature of the work called for a team outfit for the earth work and with the rock so scattered that it was necessary to take it out by hand and teams.

He used a portable air compressor, gasoline driven, with jack hammer. The sandstone was very difficult to drill, being mixed with dirt seams and, on account of the sharp grit, was very destructive to drill steel and necessitated frequent sharpening. It was found necessary to space drill holes more closely and give heavier charges of powder than when taking out hard limestone. The haul was very favorable and averaged about 250 feet. Eight hundred and eleven cubic yards of material were removed at the following costs:

Supt., labor and teams	$1,040.77
Insurance	35.39
Cost of dynamite, caps, transportation and storage of same	307.81
Use of compressor, freight, etc	128.92
Sharpening steel	44.85
Total	$1,557.74

This gives an average of $1.92 per cubic yard without profit or overhead charges.

The above information was furnished to "The Scraper," the journal of the Kentucky Association of Highway Engineers.

Draglines in Dayton

The work of the Miami Conservancy District has been practically completed insofar as the five dams and other large work is concerned, although some small jobs in the cities still remain. In looking over the records of the construction work one is impressed with the very general use made of draglines. For instance, in the reconstruction of the channel through Dayton the dragline was used almost exclusively, the greater part of the work being done with the two largest draglines used, Class 175 Bucyrus. These machines weigh 225 tons, the booms are 125 and 135 feet long, the buckets hold 3½ to 4½ cubic yards and the reach in a 180-degree turn is 250 to 270 feet. These draglines are operated by electricity. These two large machines were supplemented with two smaller ones, a Class 9½ Bucyrus steam machine and a Class K Lidgerwood electric. These machines did the odd-jobs that the big machines did not have time for or were too large for.

Along one stretch of the river no waste land could be found for dumping the excavated material, and for transporting it an unusual scheme was employed. A temporary dam was built across the river giving 10-foot depth of water

in the improved channel and in this one of the big dragline machines was floated on a scow and the material excavated by it was loaded onto other scows which were then carried some distance in the slack water to spoil banks, where they were unloaded by another machine. Further up, where it was impracticable to provide slack water for floating equipment, the material was carried to the spoil banks by standard gauge locomotives hauling air-dump cars.

In the lower part of the city the channel runs through low land and more than 1,000,000 cubic yards of material taken out of this section was used for levees and filling behind them. The general plan was to start a dragline down the center of the river, excavate the material and deposit it in a windrow as far toward the river bank as the machine would reach. Later the same machine or another would pick up this material, swing round in a half circle and deposit it in another windrow. It was found cheaper to make three windrows with the dragline machine than to load and transport the earth; it was usually necessary, however, to make only one or two throws to get the material into final position.

More than 2,000,000 cubic yards was taken out of the river channel and 129,000 cubic yards was taken from borrow pits for levee work. To accomplish this the draglines travelled up and down and across the river a total distance of over 33 miles. On Wolf Creek, a tributary of the Miami, much of the levee work was done with a small dragline.

In Hamilton, also, draglines were much in evidence. Last year an electric dragline, a Class 14 Bucyrus caterpillar dragline, a Class 14 Bucyrus mounted on rollers and a Model 21 Marion dragline were all at work at different points in the river through the city, grading roadway approaches and doing other earthwork. In fact, the reports of the Conservancy District mention little equipment other than draglines used in any of the large jobs of earth handling connected with the channel improvement.

Rapid Transportation of Track-Laying Apparatus

The advantages of track-laying apparatus such as steam shovels, concrete mixers, etc., are many and well known, but they generally are incapable of anything like speed. While they can move rapidly enough in connection with the work which they are performing, it is sometimes desirable to transport them from job to job at a considerably greater speed.

To effect this, a contractor of Los Angeles, E. E. Schilling, has built a special truck for carrying a 30-B Bucyrus shovel from job to job. A trailer has been built consisting of two trucks connected by a pair of I-beams sufficiently strong to carry the shovel and mounted at such heighth that, when the shovel is resting upon them, the continuous track is raised a few inches above the ground. In order to get the shovel on to the trailer, a pin in the front truck of the trailer is removed and the truck pulled out of the way while the front ends of the I-beams rest upon the ground. Blocking is placed on each side of the I-beams so that the shovel can be run by its own power on to the blocking and straddling the I-beams. The I-beams are then raised to position and connected again to the front truck after which the shovel propels itself forward and the truck is at the same time pulled forward, the shovel thus running off of the blocking until it rests upon the trailer. It is said that it takes about fifteen minutes to load the shovel upon the trailer in this way.

Standardizing Shovels

At a recent meeting of the Associated General Contractors the proposition was advanced of standardizing the ordinary hand shovel. As an indication of the importance of the subject, it was stated that ten million shovels are sold in the United States per year and that any partial failure of these shovels to develop their full efficiency as to life, or the full efficiency of the laborers using them, totals to large figures.

The points mentioned as entering into the specifications to be standardized are the length and gauge of the blade, length of handle, lift of blade, quality of steel, surface of blade, shape of blade, socket straps, balance in the hand and brand. The blade lift or distance of the center of the blade above the floor when the shovel is lying flat, determines the height of the handle above the ground when the shovel is entering the ground at a given angle, and this is of course important as regulating the position of the shoveller when using the shovel. If the gauge of steel used is too heavy, the shoveller employs an unnecessary amount of work in handling the shovel, while if it is too light, it of course wears out too quickly. A change of one gauge adds about four ounces to the weight of the shovel. The surface of the blade may be that of the sheet iron from which it is cut, and if it is unpolished is not so apt to rust quickly as if it is polished, but if the surface is polished smooth the shovel will enter the earth more easily and give a greater output per man-hour. Polishing costs the contractor about $1.50 per dozen. Hollow-back blades are likely to accumulate dirt, which adds that much extra weight to be handled with the shovel, and thus the shape of the blade is important.

In the matter of maintenance of shovels, it was stated that a shovel should be cleaned after each day's use and oiled to avoid pitting and rusting. It should be sharpened with a file or emery wheel as often as it gets dull. The area of the blade and consequently its approximate efficiency is decreased about 5% by the wearing off of one inch of the end of the blade.

It was stated that the output of a shoveller can sometimes be increased ten to twenty per cent by giving him a shovel of better quality or shape. There are perhaps two thousand variations in shovels manufactured today and it was believed by the speaker that a great many of these were wasteful of energy and should be entirely eliminated and that shovel designs could be cut down to a very small percentage of 2,000. As an illustration of what is

possible, the case of the wheelbarrows has been cited where styles have been cut down from 165 a few years ago to 30 at the present time.

Storing Contractors' Equipment

Some suggestions for the storing of equipment to prevent deterioration and malicious damage while idle.

"It is not reasonable to expect that if you dump a timber derrick on the ground with all the metal parts attached and make no effort to protect either metal or timber from the elements you can go out in the Spring and find your derrick all shipshape and ready to set up ready for work. Even if nothing has been stolen, the timbers are liable to be chipped and warped, the metal parts rusted and the sheaves seized on their shafts." Thus does the "American Bulletin" begin a brief article offering advice to contractors to properly store their equipment. The Bulletin then goes on to describe a good example of satisfactory storage at moderate cost, which description may be condensed as follows:

The George J. Grant Construction Company at St. Paul uses for storage a level, sandy tract, from which the company had previously removed about 500,000 cubic yards of sand and gravel down to the street level. A section of this tract was leveled off and storage sheds erected. The sandy soil afforded good drainage and the plot was located convenient to railroads and paved streets. Here the company has built carpenter, machine and blacksmith shops, tool house, garage and storage sheds for derricks, hoisting engines, etc. A stiff-leg derrick handles heavy pieces.

The company owns twenty-five stiff-leg derricks and these, on arrival for storage, are taken apart and given two coats of white lead mixed with enough lamp black to produce battleship gray. All the metal parts are removed and thoroughly oiled, marked and stored in the tool house while the timbers are stored in a shed 150 feet long, 50 feet wide and open at the ends to permit ventilation and teams and trucks to drive through. This shed is of wood with corrugated iron sides, the roof covered with roofing paper. The main upright posts supporting the shed are 14x14 inches and support five iron cross beams to which a hand-power crab is attached for loading and unloading the timbers. The timbers are piled on five large iron beams as sills, while five 2x4s are placed between each two tiers to insure ventilation. Care is taken to so place the timbers that any sag or belly acquired in service will be corrected by the weight of the timber.

Hoisting engines are taken to the machine shop, knocked down and overhauled by machinists who are familiar with them. All fittings are removed and covered with heavy lubricating oil and packed in marked and numbered boxes so they can be found readily. Bearings are oiled to prevent rusting; the cylinder head is removed and the cylinder wiped dry on the inside and coated with oil; while packing is removed from the stuffing boxes to keep the rods from rusting. All bright parts of the engine are slushed with heavy grease or, if the machine is to be kept in storage for some time, a mixture of white lead and tallow melted together, which stays in place better than grease and can be removed readily with kerosene. The boilers and frames are stored in a weather-tight shed 400 feet long and 50 feet wide, covered with corrugated iron and substantially built to keep out prowlers. Before the boilers are drained, a quantity of crude oil is put on top of the water, which is then allowed to run out slowly, a coating of oil being thus left on the tubes and plates. In this same shed are stored dinkey locomotives, concrete mixers, gasoline engines, etc.

The cabs of steam shovels stored in the yard are made as weather-tight as possible and all small parts are removed and stored in the tool house. Form timbers, wheelbarrows and similar equipment are stored in the open but are stacked so as to minimize deterioration. Shovels, picks, hammers, wire rope, blocks, etc., are stored in the tool house, every piece being cleaned and oiled. Clips are removed from the wire ropes, cleaned, oiled and the nuts worked back and forth a few times to make sure that the oil covers the threads of the bolt. Sheaves are cleaned and oiled. Wire rope is lubricated and carefully coiled or stored on reels.

About twenty men are employed around the shops and yards during the Winter months, these including machinists, carpenters, barn men and laborers. Three men are employed all the year round repairing wagons and wheelbarrows, sorting lumber and doing other odd jobs. The store yard is watched by Airedale and police dogs which have been trained to the work from puppies. Each dog has its beat which it traverses on runway chains; that is, a chain with a ring over a long trolley wire.

Pennsylvania Automobile Tags

State Highway Commissioner Paul D. Wright has announced that he has already decided upon the color arrangement for automobile license tags for 1924. It is thought possible that the number of tags required next year will exceed 1,000,000, about 860,000 being necessary for the 1923 requirements. The 1923 Pennsylvania tag has gold numerals on a blue background and the 1924 tag will have blue numerals on a gold background, and it is stated that probably these two colors will be used henceforth on Pennsylvania tags, alternating the base and numeral colors each year. During the past sixteen years Pennsylvania has used for numerals white, black, red, brown and gold, and for backgrounds three shades of blue, vermillion, yellow, white, mahogany, olive green, black, orange, brown and cream.

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Some Considerations in Selecting Excavating Equipment

Occasionally we hear a contractor remark that this idea of labor-saving equipment is all bunk—that the machinery costs more than the labor saved. While it is undoubtedly true that in some cases the ultimate cost of mechanical equipment, including transporting to and from the job, maintenance, etc., does not warrant substituting it for hand-labor, it is generally worth inquiring into whether the contractor making this remark has not been unwise in the selection of his equipment.

Where there is more than one piece of equipment, the several pieces should be adjusted to each other in capacity and otherwise, and all should be adjusted to the job itself. For instance, a 3½-yard steam shovel should not be used with 1½-yard dump cars, nor, on the other hand, would a 1½-yard shovel be used with 20-yard cars. A steam shovel costs money every minute, whether it is actually earning it or not, and it is most economically used only when it is kept busy performing its function of delivering dirt to cars or carts; which necessitates having enough cars to keep it hustling continuously. This, of course, requires at least two trains of cars, one being filled while the other is delivering its load and returning, or a sufficient number of trucks or wagons. Whether more than two trains are necessary, and the size of train, is determined by the size of car and length of haul.

Consider again the locomotive. This should be kept working up to its safe and effective capacity by the size of train it carries and the grade to which the track is laid. It needs little more than a statement of the fact to make it evident that if either of these three—steam shovel, dump cars and locomotive—is out of proper proportion to the others, one or all must be failing to deliver the maximum return for their cost, and may even be operated at a loss.

Not only must the items of equipment be adjusted to each other, however, but also to the job. Where a heavy cut is being made or for other reason a large amount of earth will be handled over a fixed location of track, heavy standard-gauge track carrying large-capacity cars and powerful locomotives may be used. The moving of such track, however, involves much more delay and expense than the moving of light track. Consequently, where there is shallow grading over a considerable area, a 24-inch gauge track carrying 1½-yard or 2-yard cars can be moved much more easily and quickly with practically no delay in the work. Moreover, with light cars of this kind much lighter temporary trestles, bridges, etc., can be used, the track can be carried over softer ground, etc. These small cars of course mean that ¾-yard or 1-yard dippers must be used on the steam shovels, or the cars may even be filled by hand.

Where the excavating is very shallow, consisting

MAKING FILL ACROSS MINNESOTA RIVER BOTTOMS

only in moving the top soil over a considerable area, it probably would not pay to use cars at all, but horse-drawn carts, which can change their route with every trip, would be preferable, or scrapers if the haul is short.

In modern highway work almost all conditions of excavation are found. Years ago highway cuts and fills were usually confined to a few feet depth, but now 25 feet or more is by no means uncommon. An illustration of this is the construction of Lindale Avenue leading out of Minneapolis, built by A. Guthrie & Co. This contract called for grading and gravelling 12 miles of road, part of which crossed the flats of the Minnesota river which lay 75 feet below the bluffs on either side. Cuts were made in the bluffs and the excavated material used to fill across the bottom, 400,000 cubic yards being removed from the two excavations and the maximum depth of cut being 65 feet. Here a trestle was built across the river bottoms and the material dumped from the trestle. This was unusually heavy work and 4-yard dump cars were used in trains of 11 cars each, five of such trains being operated from one side and four trains from the other.

As to the advantages of light dump cars and light track as compared to dump wagons, J. F. McFarlin, superintendent for W. M. Keesecker of Youngstown, Ohio, gives his opinion as follows, referring to the 1½-yard dump car:

"They are as flexible as dump wagons. They will do anything a dump wagon will do and some things which a dump wagon can't do. The 20-pound track is easily shifted. If a car gets off the track onto soft fill, two men can put it on again. Three men take care of dumping two trains of six to eight cars each—on 5% grades—and maintain the track. Each car is loaded with fully two cubic yards. We put stones on those cars sometimes, so large that they cannot be dumped. It is a simple matter to take off the side doors and slide the stones off. It is abuse, I know, but the cars seem to stand it."

Contractors now have the choice of a wider variety of sizes, types and makes of scrapers, shovels, excavators, wagons, cars and other earth handling equipment than ever before, and can therefore make more profit than ever before if they select their equipment wisely for the work in hand; and can lose more if they make an unwise selection. The day of the pick-and-shovel-and-dump-cart contractor is over except for small jobs or exceptional circumstances, and they must be pretty small or exceptional at that.

Paving in Nebraska

The president of a large firm of contractors in Nebraska has recently expressed the opinion that in that state the cost of paving this year will be about the same as last, although some of the paving materials may cost a little more and this may be reflected slightly in higher paving costs. He reported a greater demand for labor than a year ago. He estimated that the cost of paving now is approximately 25 per cent. less than it was five years ago. More paving is anticipated in the smaller cities of the state than in the larger ones.

Highway Information in North Dakota

Reference was made some weeks ago to the value that the cause of good roads and the citizens of many of the States derive from the bulletins published by the State Highway Commissions, in most cases once a month. We have just received a bulletin of the North Dakota State Highway Commission containing the following foreword:

"The State Highway Commission has never felt that it had sufficient funds to regularly publish a bulletin such as most highway departments get out. For this reason the people of North Dakota have had very limited opportunity for becoming acquainted with the work of the department. The regular biennial report gotten out by the State Engineer being entirely too bulky and expensive to print for general distribution, it appears very proper at this time to get out a supplement to the regular report for distribution to all county commissioners, legislators and others interested in highways."

Contractor vs. Sewer

In eliminating a grade crossing at Milwaukee, a contractor, in digging foundation for retaining walls in First avenue, ran into 10 feet of wet quicksand at the bottom of an 18-foot cut. To further complicate matters there was a heavy surcharge caused by the railroad embankment alongside, the top of the embankment being 50 feet above the bottom of the trench. Under this cut ran a 10-foot concrete sewer which the contractor used greatly to his advantage, but we are wondering what happened to the sewer.

Learning of the location of the sewer, the contractor punched several holes into the crown of it under the quicksand, which in a short time drained the water from the sand and enabled the contractor to complete the excavation of the foundation and build the retaining walls and abutments for which the trench was excavated without extra expense and delay.

Our informant does not state and perhaps no one took the pains to investigate the effect of this upon the sewer, but if the quicksand is like most of that with which the writer has come in contact, water was not the only thing that entered the sewer through the holes made by the contractor.

Concrete Chimney Built in Winter

We have received from P. H. Knight, city engineer of Frankfort, Indiana, an interesting description of the construction for the municipal power plant of that city by the Weber Chimney Company of a reinforced concrete stack during weather when the temperature reached below freezing almost every day.

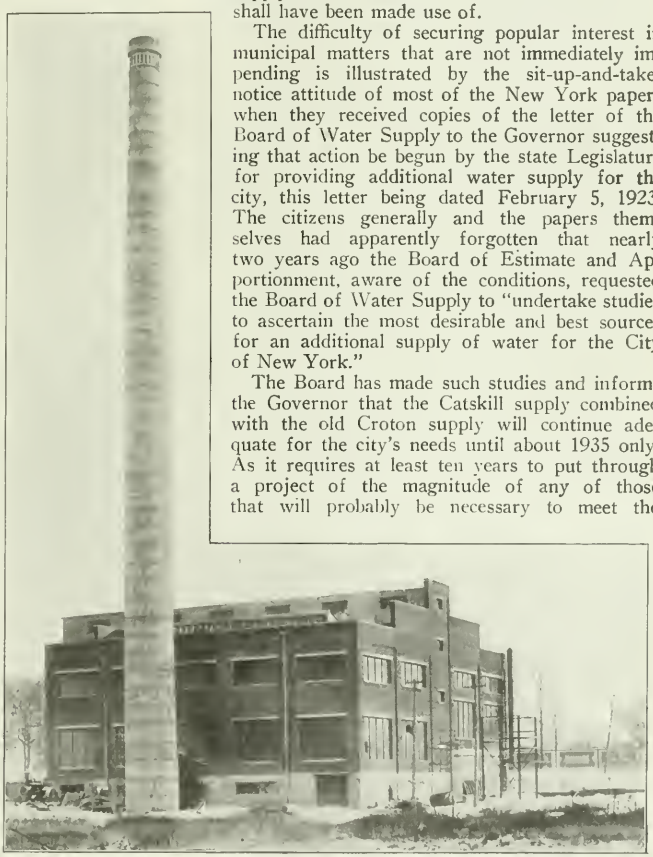
Freight embargoes and other causes prevented starting construction of this stack until last November and concreting was continued during that month and December and January, the final section being poured on January 30th.

The chimney rests on a concrete base 30 feet in diameter and extending 7 feet below the surface. The shaft rises 202 feet above the surface and has an inside diameter of 84 inches at the top and 9 feet 10⅝ inches at the base, with wall thicknesses varying from 5 inches at the top to 12¼ inches just above the base. For 63 feet above the base a 4-inch air space is left between the shaft proper and a 4-inch concrete lining.

The concrete was poured in forms of which two complete sets were used, each 4 feet 6 inches high. The concrete mixer and hoist were electrically driven. All concrete materials were heated by steam jets from an old traction engine, which also provided steam through a pipe to the air space between the stack and the lining above referred to. At night a coke fire was burned in a salamander inside the stack and during the coldest weather a tarpaulin was stretched over the top of the shaft.

Work on the shaft above the foundation began Nov. 30th, five days having been occupied in constructing the base. Owing to the days that were too stormy to work and the holidays between Christmas and New Year's, there were only 55 actual working days used for construction. The lowest temperature was 4 degrees below zero and on five days it did not reach above 14 degrees, while the highest temperature reached was 59 degrees. There were two days in January, when the wind probably reached forty miles an hour.

Mr. Knight states that "an especially smooth surface was obtained both outside and inside and, while a wash coat of equal parts of lime and cement was specified, this seems of debatable value as far as strength, durability or appearance is concerned."



CHIMNEY CONSTRUCTED DURING FREEZING WEATHER.

Delaware River for New York Water Supply

Although the Catskill water supply for New York City has not reached the point in development where all of it is available, the Shandaken tunnel not having been holed-in until Feb. 13th of this year, and it will probably be three years more before the construction work in connection with the Catskill supply is completed, consideration is already being given to the problem of where the city is to obtain an additional supply after all that is available in the Catskills shall have been made use of.

The difficulty of securing popular interest in municipal matters that are not immediately impending is illustrated by the sit-up-and-take-notice attitude of most of the New York papers when they received copies of the letter of the Board of Water Supply to the Governor suggesting that action be begun by the state Legislature for providing additional water supply for the city, this letter being dated February 5, 1923. The citizens generally and the papers themselves had apparently forgotten that nearly two years ago the Board of Estimate and Apportionment, aware of the conditions, requested the Board of Water Supply to "undertake studies to ascertain the most desirable and best sources for an additional supply of water for the City of New York."

The Board has made such studies and informs the Governor that the Catskill supply combined with the old Croton supply will continue adequate for the city's needs until about 1935 only. As it requires at least ten years to put through a project of the magnitude of any of those that will probably be necessary to meet the

demand, a beginning of the legislative procedure should be made by the present Legislature, if possible.

Among the sources of supply considered has been the Delaware river. While this river rises in the State of New York, about 65 miles from its source it becomes the boundary between that state and Pennsylvania and continues as such a distance of 82 miles, beyond which, for a distance of about 100 miles, it marks the dividing line between New Jersey and Pennsylvania. The drainage area above Port Jervis, the southernmost point on the river between Pennsylvania and New York, is 3,435 miles, of which about 70 per cent. is entirely within the State of New York. Because of the joint rights between the two states it is impossible for either of them to develop the river alone; and, as a matter of fact, its resources have not been developed nor conserved, and it is suggested that a commission be appointed by New York State to confer with similar commissions representing New Jersey and Pennsylvania to negotiate and agree upon a treaty between these states and the Federal Government with a view to such joint conservation and development.

TRI-STATE CO-OPERATION

Among the benefits to be obtained by this joint development would be: (a) A large supply of hydro-electric power which would take the place of much energy now derived from high-priced coal; (b) supplies of water for municipal and domestic consumption of the large future populations in each of the three states; (c) the equalization of the river flow with the resulting reduction of flood damages and the benefits of a more uniform low season flow.

It may be remembered that a few months ago, as recorded in Public Works, Allen Hazen submitted a report to the authorities of the State of New Jersey making suggestions and recommendations for developing a water supply for the metropolitan district of New Jersey around New York and that around Philadelphia; and that in connection with the former he recommended as an ultimate development bringing water from the Delaware across the state to a large reservoir south of Morristown. While no suggestion of the kind is made in the letter of the Board of Water Supply above referred to, it is possible that by the co-operation of the states such as is suggested a joint reservoir might be constructed which would not only bring water from the Delaware to the metropolitan section of New Jersey opposite New York, but would also supply an additional amount for use in the latter city.

Garbage Disposal in Flint, Michigan

Garbage collected by Flint, Michigan, is fed to hogs on a city-owned farm located about 15 miles from the city. The city has approximately 100,000 population and the cost of collecting for the year 1921 was $75,231. There was an increase of about 248,000 pounds of pork on the hog farm. The method has been entirely satisfactory.

Chlorination at Delaware

In spite of continuous use of chlorine at a high rate, an epidemic of enteritis occurred at Delaware, O., and the state health officials found the disinfection to be "not entirely satisfactory."

The U. S. Bureau of Public Health has made public a report on an investigation made by the Engineering Division of the Ohio State Department of Health upon the water supply of the state of Delaware, Ohio, the especially interesting features of which are the finding of the failure of chlorination and the possible influence of hog cholera on the watershed above the intake upon the failure of chlorination and upon the epidemic of water-borne disease.

The works of the Delaware Water Company, which were placed in operation in 1889, are located three miles north of the city on the Olentangy river. The original source of supply was a dug well 30 feet in diameter and 28 feet deep and, connected to it, an infiltration gallery 4 feet high, 6 feet wide and 293 feet long and parallel with and approximately 100 feet from the bank of the river. Both of these extend about three feet into bed rock. The soil formation in the vicinity consists of glacial deposits 25 feet deep overlying limestone bed rock. There is an emergency intake into the river at the end of the infiltration gallery and as early as 1895 insufficiency of the ground water supply led to the occasional use of river water through this intake. From 1896 to date deep wells have been drilled at intervals, there being at present 25 such wells, 4 of which are over 225 feet deep, one about 150 feet, one 92 feet, and the remaining are shallow tubular wells down to rock. The 150-foot well supplies most of the water derived from wells.

Because of the insufficiency of the well supply, river water was taken through the emergency intake 15 days in 1918 and almost continuously from Jan. 28, 1920, up to the time of the report. In 1917 the company installed a chlorination disinfection device. In 1920 this was replaced with a larger chlorinator, a Wallace and Tiernan of the M. S. B. manually controlled type, capable of applying from 5 lbs. of chlorine per day up to any desired amount. A venturi meter was installed to assist in accurate proportioning of the chlorine dose, and suitable indicating and recording devices registered the amount of water being pumped and of chlorine being applied.

Four times in 1920 representatives of the State Health Department took samples of the water furnished, which was a combination of well and river water, and, although it was being treated by the disinfection process, uniformly poor results were obtained, showing the disinfection to be not entirely satisfactory. In November, 1921, samples collected indicated that the water still was not entirely satisfactory from a sanitary standpoint

in spite of continuous excessive chlorination, varying between 1 and 2 parts per million. The citizens of Delaware complained regarding the chlorine tastes throughout the year 1921, from which it is evident that the company had been attempting to disinfect the water sufficiently to make it safe. There were no interruptions in the chlorine treatment, but nevertheless numerous tests by the city's consulting analyst showed unsatisfactory results in the tap water during 1921. The Health Department, therefore, was forced to conclude that in this case disinfection of combined river and well water was a failure.

During October and November, 1921, an extensive outbreak of intestinal disease occurred in Delaware. The division of communicable diseases investigated 743 cases and reported 373 as enteritis, and the public water supply was decided to be the source after a careful epidemiological study.

Inspection of the watershed conditions above Delaware revealed the fact that three farms less than seven miles above the intake had experienced an epidemic of hog cholera between October 1 and December 13, which had resulted in the death of about 40 animals, and that proper disposition had not been made of some of these, so that it was probable that the river water received serious bacterial pollution resulting from this epidemic.

Above Delaware there are one city and thirteen towns, two of which have public sewerage systems. For nine years previous to the installation of chlorine disinfection devices in 1917, the average typhoid death rate was 32.1 per 100,000, while for the four years following the rate averaged 11.3. All of the typhoid cases in 1921 occurred coincident with the enteritis outbreak, but the typhoid cases were relatively mild and no deaths occurred.

No suggestions are contained in the report (which was written by F. H. Waring, principal assistant engineer of the Ohio State Department of Health) as to the reason why the chlorine treatment was unsuccessful in this particular case. It may, however, be partly accounted for by the statement made incidentally in the report that presence of turbidity was noted in all of the tap samples collected November 28, the only date during the epidemic when samples were collected by the State Department.

OPINION OF NEW JERSEY HEALTH DEPARTMENT

In this connection it may be pertinent to quote the following from the annual report for 1921 of the New Jersey Department of Health:

> Chlorination as the only safeguard for surface supplies subject to pollution is regarded by the Department as a temporary improvement only, and it is its policy to encourage, and, under certain circumstances, demand the additional protection of prolonged storage or filtration. The reason for this attitude is self-evident. Chlorinators seem to be peculiarly liable to breakdowns in their present stage of development, and when this occurs, potentially dangerous water must be furnished the consumers without treatment of any kind.

St. Louis Public Improvement Program

At a special election in February, St. Louis voters authorized an outlay of over $87,000,000 for public improvements to be spent on twenty projects. Twenty-one projects were voted upon but $1,000,000 for a National Guard armory failed to receive authorization.

Of the twenty items the largest is $12,000,000 for extensions to the waterworks plant, to be paid for out of the waterworks revenues. Next came $11,000,000 for the River DesPeres sanitation purposes; followed by $8,650,000 for opening and widening streets, $8,000,000 for city-wide electric lighting, another $8,000,000 for construction and reconstruction of sewers, $6,000,000 for a memorial plaza and building, $5,800,000 for street-paving and improvement, $5,000,000 for a municipal auditorium and community center, $4,500,000 for a hospital and other public institutions, $4,000,000 for a new courthouse and the balance for parks and playgrounds, fire department, grade crossings, public markets and other improvements.

Under the city's charter the department of the president of the Board of Public Service has charge of all engineering and architectural work, such as streets, sewers, public buildings, etc., but has assigned to the Department of Public Utilities all construction work incident to the waterworks. Consequently the Board of Public Service will have immediate charge of the spending of $45,000,000 of the amount authorized. The department has plans all completed for immediate inauguration of some of this work, but plans for others have not yet been started. For instance, expenditures from the appropriation for paving and improving streets will be made as the various thoroughfares are ready for paving. About $600,000 will probably be spent in the reconstruction of worn out streets which have become major thoroughfares but which do not require widening, but it is expected that at least five years will be required to complete the work under this item. A considerable part of the sewer work can be started very soon, preliminary plans having been completed and most of the right-of-way having been secured for the North Baden sewer estimated to cost $840,000, for which final plans can be ready by the time the necessary ordinances are passed. The same is true of relief sewers in two districts, the combined cost of which is estimated at $1,035,000. One hundred and fifty thousand dollars is to be spent in constructing street inlets for draining sections where flooding now occurs because of insufficient inlet capacity.

It is intended to make an early start on the River DesPeres improvement, preliminary plans for which were completed sometime ago. As to the municipal auditorium, the site for this has not yet been selected but Mayor Kinsey will at once organize a conference of citizens to outline the plans for this community center. Before ob-

taining plans for the memorial building the local chapter of the American Institute of Architects will be consulted as to the best means of obtaining architectural reports of the highest order.

Buffalo's Municipal Gas Well

The city of Buffalo has driven a gas well on the city hospital property, which was "brought in" on January 29 and is giving a flow of between one-half million and a million cubic feet daily. The city has had to take special precautions to control the well, the pressure in which is 1,025 lbs per square inch. In order to do this 3,420 feet of 3-inch pipe of high tensile strength weighing about 15 tons has been placed in the well, which is anchored to the 6-inch casing which weighs about 30 tons and to the 8 and 10-inch outer casings weighing 10 to 15 tons more, giving a total weight of 50 tons. High pressure valves and fittings are used.

It is proposed to use the gas for heating, cooking, laboratory and other purposes in the municipal hospital, thus saving a considerable sum for fuel, the hospital commission having asked for an appropriation of $30,000 for this year, much of which can probably be saved by the use of the gas.

Concrete Mixers and Mixing*

By F. S. Besson†

Capacity and rating of mixers and actual output. Selecting the size suitable for a given mix and job.

Speed of Drum. The Joint Committee recommended a peripheral speed of about 200 feet per minute. This means that a drum of large diameter would be permitted to revolve slower than one of smaller diameter. Generally the drum speed has been specified in the past in terms of revolutions per minute. With practically all makes of batch mixers there is little effect on the strength of concrete within the limits of 10 to 30 R. P. M. If the drum is not overloaded, mixers as furnished by the manufacturers will give satisfactory drum speed—the main thing is to see that the charge is mixed for at least a minute.

MIXER RATING

According to the Concrete Mixer Association, the quantity of mixed concrete a mixer can deliver is used as a rating basis, and mixer numbers indicate the capacities in cubic feet of mixed concrete per batch. The amount of concrete obtained from a given quantity of unmixed material depends greatly upon the character of the aggregate, also upon the amount of water used. As a rough rule of thumb, the capacity in unmixed material per batch, for each size of mixer, in cubic feet, may be assumed to be 10/7 times the mixer number. (In place of 10-7 the ratio 3-2 is often assumed). Usually it is considered for rating purposes that mixers are able to turn out 40 batches per hour. Accordingly, since the ratio

$$\frac{10/7 \text{ is approximately the same as } 40 \text{ (batches per hour)}}{27 \text{ (cu. ft. in 1 cu. yd.)}}$$

the figures representing the batch capacities in cu. ft. of unmixed material may also be taken as representing the rated output per hour of mixed concrete in cubic yards. It must be realized that "rated output" is an arbitrary figure chosen for classification purposes. It too often differs greatly from "actual output" which latter figure depends upon the time of mixing and upon the equipment available for getting materials into the mixer and concrete away; and further upon the organizing ability of the man in charge and his efficiency in handling his equipment.

Mixer ratings are shown in the accompanying table, also bag capacities per batch for four commonly used concrete proportions.

Arbitrary Rating Table for Mixers

Size of Mixer	Capacity Mixed Concrete per Batch	Capacity Unmixed Material	Rated Output Cubic Yards per Hour	Cement Per Batch 1—3—6	1—2½—5	1—2—4	1—1½—3
No.	Cu. Ft.	Cu. Ft.	Cu. Yds	Bags	Bags	Bags	Bags
3	3	4.3	4.3	.43	.50	.61	.72
4	4	5.7	5.7	.57	.67	.81	.95
7	7	10.0	10.0	1.0	1.18	1.43	1.67
10	10	14.4	14.4	1.44	1.68	2.05	2.40
14	14	20.0	0.0	2.0	2.35	2.85	3.35
21	21	30.0	30.0	3.0	3.55	4.30	5.00
28	28	40.0	40.0	4.0	4.70	5.70	6.65
56	56	80.0	80.0	8.0	9.40	11.40	13.30
112	112	160.0	160.0	16.0	18.80	22.85	26.65

It is seen from the table that the factor 7 enters largely into the numbering of mixer sizes, and that for a 1-3-6 mixture, the sum of the ingredients being 10, the cement per batch for a No. 7 mixer equals 1 bag, for a No. 14 it equals 2 bags, and so on to 16 bags for a No. 112. This appears to explain to some extent the choice of the ratio 7-10 as a factor for changing unmixed materials to mixed concrete.

The fractional figures in the last four columns of the table do not signify that a contractor would split a bag of cement; in fact, most specifications prohibit such a procedure, though if bulk cement were used exact quantities of cement might be used in order to obtain full mixer capacity. The data in these four columns show that the scheme often followed of basing mixer capacities on rich concrete and calling the No. 10 mixer a 2-bag machine, the No. 14 a 3-bag machine, and so on, is much too general a characterization. Also these data show whether or not there is a tendency to overloading the mixer when a full bag mix is used as an approximation to the capacity of the mixer. Most manufacturers' ratings are conservative and allow for approximately 10 per cent. excess capacity on all

*Continued from page 48
†Major, Corps of Engineers, U. S. Army. Assistant to the Engineer Commissioner of the District of Columbia
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sizes, though there is some difference in mixers, rated of equal size, but made by different manufacturers. If a mixer labors under its charge, turns over slowly and gives poorly mixed concrete, it is undoubtedly overloaded. One objectionable feature connected with mixer overloading is that a tendency is created to use an excessive amount of water in order to give the poorly mixed concrete the desired consistency.

Actual Output of Mixers. Both engineers and contractors seldom realize how little time is consumed on actual work under contract, and how much avoidable delays increase the cost of construction operations. This is particularly true in the case of concrete paving. There are the usual delays which may be charged to "Administration," including, for example, time consumed in contractual formalities, shipping equipment, organizing forces, and other preliminary work carried out after the award of the contract, but before work is actually commenced. Bad weather is always the cause of many days' lost time; the only lost time, though, which is fully excusable. Moving from job to job consumes much time. Lack of materials frequently causes considerable delay which can generally be avoided by using foresight in laying out proper storage. Lack of water supply is a frequent cause of delay, often simply because water pipe too small in diameter has been purchased. In cities generally the source of supply is ample; sometimes pumps have to be installed, in which case care should be taken to have them large enough. A delay that is always avoidable is that where failure to prepare the sub-grade in time prevents continuous operation of the mixer. Waiting for the completion of accessory and incidental work, as curb setting, the installing of gas, water and other services etc., invariably uses up a great deal of time and this can be remedied only through the closest possible coordination.

In Illinois during 1921, of 102 contractors' paving mixers, one operated 129 days, two 121 days, two 105 days, and all the rest less than 100 days. In Iowa, during the same year, mixers used on thirty-one different contracts spread throughout the state averaged but 74 operating days and only 35 full days were worked, calling every day a full day if the lost time was less than three-quarters of an hour. Of 35 per cent. lost time, only 1.09 per cent. was lost because of machinery breakdowns.

Contractors Association Sues Editor

Contractors of Virginia not long ago organized as the Virginia Highway Contractors' Association, which was accused by the Winchester Star and some other papers of having as its object the obtaining of higher prices for highway work in the state. Indignantly protesting against this accusation, the managing director of the association, Robert W. Woolley, threatened to sue the owner of the Star in the sum of $100,000 for libel. Mr. Woolley states that the organization is opposed to monopoly and that he will personally combat any attempt at monopolistic practices by members of the association.

The paper sued also claims that the association is urging the people to vote in favor of the $50,000,000 bond issue, but Mr. Woolley states that the association has taken no stand in the matter but that, if anything, the bond issue would naturally be opposed by the contractors. The reason for this is that a large bond issue means that the highway construction will be let in large contracts which will be completed within a very few years and which will attract to the state large contractors from outside; while if the work is done by smaller increments spread over a longer period of time, it will not be so attractive to outside contractors and Virginia contractors can probably secure all the work and keep busy at it for many years to come.

Cleveland's Grease and Tankage Prices

The city of Cleveland, Ohio, in December awarded contracts for the purchase of grease and tankage produced at the municipal garbage reduction plant during the first six months of the year 1923. The tankage to be sold was estimated to be approximately 700 tons a month, the city retaining the right, however, of holding out not to exceed 50 tons per month should it desire. The price paid was to be f. o. b. Willow, Ohio, and would be on the basis of analyses, the bidder stating how much he would give for each unit of ammonia, of bone phosphate of lime, and of potash; the tankage being shipped in bulk in carload lots. Analyses are made by the city chemist as a basis of payment, but should the buyer's chemist arrive at results different from these by not exceeding 1% in bone phosphate, 0.2% in ammonia and 0.1% in potash, the analyses of the buyer and seller are averaged as a basis of payment. If two or more of the respective figures of the analyses of buyer and seller exceed these limits, but in such a manner as to leave the final monetary value of the shipment practically the same, the figures of one party are to be accepted for the ingredient and the figures of the other party for the other ingredient. If, however, the analyses vary so widely as to render settlement impossible, a duplicate sample is to be submitted to a third analyst of national repute agreeable to both parties and his results shall form the basis of payment; the cost of this analysis being borne by the party whose analysis differed most widely from it.

The ammonia is to be determined by the Kjeldahl-Gunning-Arnold method as given in the U. S. Dept. of Agriculture circular No. 108. All other determinations in the tankage analysis are to be made by the official fertilizer methods of the Association of Official Agricultural Chemists. Payments are to be made within ten days after receiving the bill for the same, regardless of any differences in analysis, but these are to be adjusted at once in the way described above.

Each car of tankage is to be weighed on the city's scales at the garbage plant, these scales being certified to and sealed by the City Sealer of Cleveland, or on the scales of the Baltimore & Ohio Railroad if the city's scales are out of commission.

Only one bid was received for tankage, and the contract was awarded to that bidder, The Packing House By-Products Company, the prices offered being $1.25 for each unit of ammonia, 10c for each unit of bone phosphate of lime, and 70c for each unit of potash. This is estimated to give an average of about $6 per ton.

Six bids were received for grease as follows: The M. Werk Company, $4.21½ per cwt.; the Rub-No-More Company, $4.41; The Packing House By-Products Company, $5.03; The Wilson Martin Company, $5.06; C. E. Woodworth, $5.75; Charles L. Gohr, Jr., $5.87½. This contract was awarded to the highest bidder. This price for grease is about 40% of that received in 1918, but is higher than that received either in 1914 or in 1915. In the case of the tankage, the price received is about 32% of that received in 1918 and about 60% of that in 1919 and practically the same as that received in 1913.

The contract for the purchase of the grease provides that it shall be sold on the usual basis of 97% available fats, the amount of dirt, moisture and foreign substance or unsaponifiable matter being determined by the city chemist. It is estimated that the grease will amount to about 500,000 pounds per month. Should the buyer's chemist differ from the city chemist in his analysis, "he shall have the privilege of testing and checking the analysis at the city laboratory, and if such test shows an error in the analysis by the city chemist, then the bill shall be corrected to conform to the result of the test and all the expense of making such test, including the traveling expenses of the buyer's chemist, shall be assumed by the seller." Unsaponifiable matter is to be determined by what is known as the Morawski & Demski method. The hydro-carbon is to be dried in a dry oven at 105° centigrade for at least five hours. Extraction is to be carried on three times, using first 100 c. c., then 75 c. c., and then 50 c. c., for the solvent. The petroleum ether used in this determination shall be clear distillate testing 86° Beaume, leaving no residue when evaporated on the steam bath.

Abuse of Separate Sewers and Storm Drains*

The ways in which such abuse is practiced, the causes therefor, and remedies suggested. Sewer misuse "little short of an engineering calamity."

The object of this paper is to present in a forcible manner the present status of many of the systems of separate sewers and storm drains in this country, to sound a note of warning against a continuance of abuses now more or less generally prevalent, and to offer some suggestions which insofar as they may prove practicable of adoption, may restrain misuse and thus tend to avert a general condition which appears to the author in some specific cases to be little short of an engineering calamity. The membership of this Society perhaps has a better opportunity than that of any other to render helpful service in this field.

Definitions. A committee of the Sanitary Engineering Section of the American Public Health Association has presented the following pertinent definitions:

"A separate sewer is a sewer intended to receive domestic sewage and industrial wastes without the admixtures of surface or storm water."

"A storm drain is a conduit for carrying off surface water and storm water."

"A combined sewer is a sewer intended to receive domestic sewage, industrial wastes and surface and storm water."

ABUSE OF SEPARATE SEWERS AND STORM DRAINS

In a paper entitled "Prevention of Misuse of Sewers,"† Mr. W. H. Dittoe has stated clearly the manner in which storm drains and sewers are being misused, as follows:

> Sewers are designed for definite purposes and if used for other purposes are being misused. Storm drains are misused if receiving sewage, industrial wastes or other wastes of objectionable character. Combined sewers are properly used when removing all classes of liquid wastes, but are misused if receiving industrial wastes affecting sewerage systems or processes of sewage treatment.
>
> Sanitary sewers, as the name implies, are for sanitary purposes only, and are misused if they receive drainage from the surface and roofs, subsoil drainage such as may be admitted by building foundation drains and through open or leaky joints, and industrial wastes of a character to affect the sewage or treatment processes.

Combined systems with intercepting sewers and storm overflows permit the discharge of sew-

* A paper, somewhat condensed, before the American Society for Municipal Improvements, by Harrison P. Eddy, of the firm of Metcalf and Eddy, consulting engineers.

† Public Works, January 7, 1922.

age mingled with storm water through such overflows into water courses. In general the total quantity of sewage (not including storm water) thus discharged probably aggregates from 2 to 5 per cent. of the total quantity produced during the year. One of the important objects of separate sewers is to prevent this periodic discharge of sewage into small streams and bodies of water.

In many cases, however, sewage is discharged into storm drains through incorrect house connections, and even through common sewers which have been connected with storm drains. This in greater or less measure, as the case may be, defeats one important objection of the adoption of the separate system in preference to the combined system. Such discharge is not confined to periods of storm, but is continuous and may readily constitute a greater source of pollution and offense than sewage discharged from combined sewer overflows in times of storm. Only from 2 to 5 per cent. of the building connections wrongly made would be required to provide a quantity of sewage equal in the aggregate to that discharged from combined sewer storm overflows. In many cases the continuous discharge of sewage from even a smaller proportion of the houses would constitute a greater source of annoyance on account of its discharge in dry weather and at times of low stream flow.

Great annoyance and damage have resulted from the discharge of storm and ground water into separate sewers. This occurs through the connection with the sewers of roofs, street inlets and foundation and cellar drains, and in some cases even small brooks. Sewers are sometimes so poorly built that they receive large quantities of ground water that should be cared for by natural channels or storm drains. Even where the sewers are most carefully built to exclude extraneous water, the house connections are often so improperly made that large quantities of ground water find access to the sewers, thus nullifying the effort and money expended in securing excellence of workmanship in their construction.

The results of such abuses have been serious in many places. In others, however, the ill effects have not yet been so important, because the improper connection of roofs and inlets and the faulty workmanship upon sewers and house connections go on gradually and considerable time may be required for their cumulative effect to become such as to cause damage and demand public attention. The effect of such abuses is destined to increase greatly as time goes on.

ILLUSTRATION OF SURCHARGED SEWERS

In one case a city has been compelled to approximately double the size of its sewage treatment plant, solely because of the admission of water to separate sewers. The sources of this water were many, including defective house connections, street inlets, perforated manhole lids particularly within street car tracks, and abandoned house connections which were not sealed when buildings were burned or removed.

One of the most important sources in this case appears to have been wet cellars from which water was drained to the separate sewers through the cleanouts in cast iron soil pipes laid below cellar floors. There are many buildings located on side hills in some of which there is ledge. During and after rains, large quantities of ground water enter the cellars, and the owners, or tenants, remove the caps from cleanouts and allow the water to drain out. In some cases the cleanout caps have been left out continuously.

So large a quantity of water is admitted to the separate sewers in this city that the trunk sewer some three miles long is often overtaxed, and occasionally the sewage has escaped through the manhole covers into the streets and run over the ground into a neighboring water supply reservoir, which, finally, was protected by sand filters built to receive the sewage before it could reach the reservoir. The trunk sewer should be augmented now although it is of ample size to serve the city adequately for many years to come were it not for this abuse of the separate sewers.

Considerable money has been expended in an effort to remedy the defects in this system. Street inlets have been disconnected, perforations in manhole covers have been closed by means of rivets, abandoned house connections have been sealed, and one sewer has been rebuilt, but the net result of this work has been small. It is practically impossible to correct many of the defects. Fortunately the growth of the city has been comparatively slow and the separate sewers are serving a useful purpose notwithstanding their defects. However, from the point of view of the service which might be rendered by the system under reasonably favorable conditions, it has failed in large measure.

Probably few systems of separate sewers have been so designed that they can receive the roof water from more than about 1% of the tributary houses without being surcharged at times of intense downpours after the districts they are to serve shall have been built up to the extent contemplated in the design. If there are also other source of admission of water, such as street inlets and perforated manhole lids, the number will be correspondingly less.

In some places the sewers have been surcharged to such an extent that sewage has flowed back through house connections into the cellars, while in others it has escaped through manhole covers into the streets. Just how far such conditions can be tolerated without justifying the statement that the sewer system is a failure, is a debatable question.

Such abuses may ultimately require enlarged treatment and pumping plants, increased operating expenses and augmenting the sewer systems, first by relieving the main sewers, and later the submain sewers and perhaps even the lateral sewers.

It is believed that these are not isolated cases and that these conditions are rather general. On the other hand, some systems have been satisfactory. This is probably particularly true in very

small slow-growing communities and where the local administration has been good.

CAUSES OF MISUSE OF SEPARATE SEWERS AND STORM DRAINS

The principal causes of the misuse of separate sewers and storm drains may be grouped in six classes as follows:

First, ignorance of the purpose and objects of the sewers and drains is an important cause of their misuse. This ignorance is often due to lack of proper instructions from those designing the systems. It is due also in many cases to frequent changes in administration, as a result of which officials many times are entirely ignorant of the intent and plan of the systems. Sometimes many, or all, of the records and drawings are lost or have never been properly filed for available use in the municipal offices. In such cases whatever knowledge there may be is often lodged in the minds of a few tradesmen such as building contractors and plumbers. In some places this knowledge is a portion of their stock in trade. They make the connections for the building owners, sometimes in the cheapest possible manner, regardless of known proprieties, and in others incorrectly, through ignorance.

Second, misuse has arisen also from indifference of municipal officials. In one instance coming under the author's observation the city officials having jurisdiction over the making of house connections and the operation and maintenance of the sewer and drainage systems, apparently made no effective effort to secure correct connections, notwithstanding that they were formally notified of the intended use of the sewers and drains, of the fact that connections were being improperly made, and that a continuance of the existing policy would thwart the plan adopted for maintaining the natural water courses in a clean, presentable condition and would result in the surcharging of the separate sewers and in injury to property due to flooding, for which the city might be legally liable in damages. Such indifference may arise from many causes, some of which naturally fall under the other groups herein discussed. Probably the most important is the lack of moral stamina to require the making of proper house connections by building owners, notwithstanding their protests urged as a matter of personal privilege.

Third, lack of authority to enforce suitable regulations has been a cause of misuse in some instances. Where there is no state law or municipal ordinance the city official having jurisdiction must assume the authority, which requires a strong personality. An official assuming such authority will often find himself without the support of superior officials.

Fourth, favoritism or "pull" has undoubtedly played an important part in permitting the making of incorrect house connections. While the relative number of cases which can be so classified may be small, their existence tends to undermine the authority conveyed by law or assumed by the official in charge. If there is precedent for disregarding regulations, many requests for such privilege are likely to follow. It is cheaper to lay one connection than two. A building may be provided with a sewer connection, and later the discharge of roof water on to the ground may become a cause of annoyance. It is obviously a simple matter to discharge this roof water into the soil pipe connected with a separate sewer, and the owner is likely to feel that it is a great hardship to be obliged to lay a new connection all the way from his roof water pipe to the public drain. Additions to buildings frequently require the disposal of surface water. These additions may be very small, such, for example, as a bay window or piazza, and the official who has the moral stamina to require the owner to lay a drain to the public sewer for the purpose of serving such a small addition, is likely to be severely criticized by the owner.

Fifth, surreptitious connections undoubtedly have been an important cause of the misuse of sewers and drains. In many cases, particularly in times of high cost of construction work, building owners undertake to make certain improvements or repairs directly, or through the employment of journeyman mechanics. Often, too, it happens that such mechanics are the owners of buildings, and it is natural for them to do their own work where practicable. Over such work the city officials have no control, as application for permits is not made. Building owners are often annoyed by surface or ground water where no drain is available for its reception. Explanation and argument on the part of the city official usually afford the owner little satisfaction. This is particularly true in cases where he has paid the same sewer assessment as his neighbor in front of whose property the storm water drain was constructed. The owner who lacks the drainage facilities is certain to feel that he has been inequitably treated, and there is no doubt that in many cases he has attempted to square accounts by making the needed connection with whatever pipe was available and without the knowledge of th officials. The discharge of cellar drainage through the soil pipe cleanouts has already been discussed.

Sixth, in relatively few instances misuse has undoubtedly been due to incorrect connections made through error. In some cases the pipes between the building and the public sewer are laid in advance of the installation of plumbing. Later the plumber may readily mistake the sewer connection for the drain connection and transpose the tributary pipes within the building. In other cases the plumbing is first to be installed and the drain-layer may erroneously connect the soil pipe with the drain and the roof water system with the sewer. Probably such errors constitute the least serious of the causes of improper connections.

(To be continued)

Notes on Bluefield's Sewer Report

A report on extension and improvement of the sewerage system of Bluefield, West Virginia, has recently been submitted to the city authorities by Morris Knowles, Inc., which contains a few paragraphs that are of general interest.

The first of these deals with the comparative advantages of the separate and combined systems as determined under Bluefield conditions. The engineers recommend the separate system for the following reasons:

1. A separate system avoids heavy rock excavation incident to placing large storm water conduits sufficiently below cellar floors to avoid flooding of cellars.

2. The separate system permits improving of sanitary conditions at minimum expense. This applies particularly to areas having good natural drainage.

3. The separate system utilizes, to the greatest possible extent, the existing sewer construction.

4. The separate system involves minimum expenditures for future construction and operation of sewage treatment plants.

At present there are both combined and sanitary sewers in the city. The latter total about thirty miles varying in size from 6 inches to 15 inches, 6-inch pipe having been used extensively. There are only about 175 manholes in the thirty miles, or less than 6 to the mile. This "makes it impossible to obtain definite information regarding detailed location and exact grades." These sewers appear to have been operating satisfactorily and it is proposed to retain them to a large extent, but for future construction 8-inch pipe is recommended as the minimum size "for the reason that an 8-inch pipe is much less liable to clogging than a 6-inch pipe and involves only a moderate increase in cost above that of the smaller size mentioned."

In providing for storm water, attention is called to the objections found practically everywhere as well as in Bluefield to open streams running through the city, which are used as dumping places for miscellaneous rubbish and frequently become choked during times of spring floods. It is therefore proposed to substitute large enclosed concrete conduits for the present open channels.

"To avoid undue amounts of rock excavation, the larger drains have been designed as wide, shallow culverts with inside heights varying from 3 to 4½ feet. The top of these culverts is maintained at a distance of approximately 1½ feet below the gutter grades of adjoining streets in order to afford adequate surface drainage." The lots along considerable lengths of the sewers are below the sewer grade, but the deepening of the drains to remove storm water from these low-lying areas is considered impracticable on account of the excessive rock excavation involved. Instead, it is suggested that the low areas be filled up as fast as practicable.

City Furnishes Garbage Cans

The city of Bucyrus, Ohio, on receiving a deposit of $2.00 from each householder, will furnish garbage cans for his use and replace them when they become unfit for further service.

Cleaning Drainage Channels with Dragline Excavator

The Rio Grande project of the U. S. Reclamation Service embraces about 150,000 acres, the object of the project being to drain the area, portions of which had become so water-logged as to be useless for any purpose. Construction of open drains was begun in 1917 and has benefited over 100,000 acres, which area is now suitable for cultivation. The total project includes 350 miles of drainage canals, and it is expected that they will be completed by October of next year.

In general, the drains were carried to a depth of 10 feet with side slopes of 1½ : 1 and a bottom width of 12 feet. A small amount of the excavated material was thrown upon one side to be levelled off for a roadway, while the balance was thrown into a spoil bank on the opposite side.

Soon after the completion of the drains, the banks began washing and sliding and filling up the bottom of the channel. This was accompanied by a heavy growth of tules in the bottom of the canal. In some cases canals three years old were found filled from 2 feet to 4 feet above the original bottom and with the entire bottom covered with tules which filled the channel and retarded the flow, this checking of velocity resulting in further deposits of sediment. The weeds have been cut from time to time, but this is an expense and of very temporary benefit.

Not long ago it was learned that watercress killed off tules and experiments are now being made to determine whether it is practicable to plant watercress in the drainage channels for this purpose.

In 1922 the accumulation of silt had so raised the grade in the Mesa drain in El Paso Valley that cutting the weeds would no longer suffice, and it was decided that the channel must be excavated to its original depth. This work was done by the use of a Pawling & Harnischfeger Excavator with a 37-foot boom and using a ½-yard bucket. With this machine, which travelled along one bank of the drain, the waterway was lowered to the original depth, but with a width of 6 or 7 feet instead of the original 12 feet, one object of this being to minimize further settling of the banks. The machine, using this small bucket and a shortened tripline, was able to remove the sediment from the channel without removing the growth on the slope and on the bench formed by the sluffing-off of the slope, thus leaving this growth as a protection against further sluffing, care being taken not to drag the bucket against the old bank. By taking pains a neat, uniform slope of bank was obtained and a bottom width of 6 to 8 feet, carried very closely to the original grade. By lowering the channel from 2 to 4 feet, the water surface in the drain was lowered from 1½ to 2½ feet.

Nine and a half miles of drain were cleaned in this way at a total cost of $3,149, or about $330 a mile; 40,875 cubic yards of material being removed at a unit cost of 8c. The average progress per day was 600 feet. In connection with this work the excavator made its own road ahead of it by levelling off and adding to the small spoil bank on this side, and also repaired breaks in the side of the drain caused by the wash of irrigation water flowing into it from the adjoining fields.

A comparison was made of cleaning drains working up grade and down grade, and it was learned that the down grade was the most successful. When digging up grade, much of the material was washed downstream and deposited there, raising the grade of the drain below which had been already lowered. It was even necessary in several instances, when the machine stopped operating for repairs, to place a sheet-pile cutoff across the drain to prevent the material above from washing down into the channel. It was at first thought that when digging down grade the bottom material would run back between shifts, but this did not occur, even when digging was interrupted for an entire day.

Cost of Water Main Laying in Detroit

The annual report of the Board of Water Commissioners for the fiscal year 1921-22 gives unit costs for laying watermains of different sizes, to a total amount of 145 miles. The department uses labor-saving appliances to a considerable extent, but the details of the several jobs are not given in the summary.

The various jobs are grouped according to the size of pipes laid. The largest single item is 6-inch pipe, of which 202,167 feet were laid. The cost per foot for this pipe was as follows: For material, $1.33; cartage, 7c.; labor, 86c.; machine, 6c.; overhead, 31c.; a total of $2.63.

That the figures given are not of great value unless explained in considerable detail is indicated by an inspection of them. For instance, the average cost per foot of carting 12-inch steel pipe is given as 14c., while carting 16-inch steel pipe averaged 9c. Carting 42-inch cast-iron pipe averaged $4.41 per foot, while carting 48-inch averaged only $1.03. The labor item for 3-inch pipe is given as $4.40 a foot, for 6-inch pipe 86c., for 12-inch pipe $3.64, 24-inch $3.92, 30-inch $4.74, 36-inch $6.19. These last are all cast-iron pipe and are fairly proportional to the size. Comparing the cost of cast-iron and steel, we find the labor for 12-inch case-iron given as $2.48 and for steel as $1.43; for 16-inch cast-iron $3.64 and for 16-inch steel $2.47; for 24-inch cast-iron $3.92 and for 24-inch steel $2.99.

Where the quantities are considerable, the variation in cost of material should be more closely proportional to size and material than most other figures. We find 12-inch cast-iron pipe costing $3.31 per foot and 12-inch steel $2.89 (cast-iron presumably including the lead for joints as well as the pipe itself); 16-inch cast-iron $6.54 and 16-inch steel $4.12; 24-inche cast-iron $8.84 and 24-inch steel $6.34.

Snowless Roads in Wyoming

The December issue of the Wyoming State Highway Department's *"News Letter"* gives on its editorial page the information that "Heavy snow, unaccompanied with wind at the time of falling or shortly thereafter, is so unusual for Wyoming that it is scarcely worth while to reckon with it, so that it is doubtful if we will ever be obliged to consider an extensive program of snow removal. Fortunately the wind accomplishes this for us, provided we give it a chance." To know that practically every snowstorm is going to be a blizzard may not be an unmixed blessing for a country, but at least it seems to have its compensations, judging from this editorial statement. Apparently in that country snow plows are unnecessary if only highway cuts be avoided.

However, the highway engineers must take advantage of this local peculiarity of snowstorms. Says this editorial: "The worst conditions exist . . . on some of the projects which were constructed before Wyoming came to find out that the usual custom of balancing cuts and fills must be disregarded and highways be graded up above the ground level in all cases to allow snow to blow off, and thus clear the road. In rough country this, of course, cannot always be done; but, by following the general policy and making proper use of snow fences where needed, the Federal Aid road can be made so nearly snowproof that, with but little work, traffic can be kept going at all times."

Snow Removal in Rhode Island

The State Board of Public Roads of Rhode Island has kept 366 miles of state highways open after snowstorms at a cost this winter estimated at the end of February to be approximately $22,000. Forty-eight motor trucks and three tractors are used, equipped for snow removal and operated by crews of three men each—a driver, snow-plow operator and spare man to assist in forcing drifts.

Not all the equipment starts out in every storm. A certain number leave the stations when the snow is 2 inches deep. If there are indications that the storm is to be too severe for this limited number to keep the roads open, a second installment is added, thus enabling each to shorten the length of its beat. The third installment consists of the tractors, which do not go out unless conditions are extraordinarily bad and involve extremely heavy snow and serious drifting. At the outset efforts are made to maintain vehicular traffic by clearing a roadway 18 to 25 feet wide. On the day following the storm the force pushes the snow back further to make room for the next snowfall. About ½-inch of packed snow remains, but the first thaw quickly melts this and leaves a clean pavement.

In the streets of Hartford, Connecticut, the city has used snowplows on 5-ton motor trucks to clear residential streets, and steam shovels with caterpillar tread to load motor trucks at a less cost per cubic yard than by doing the same work by hand labor.

Garbage Collection Statistics

Information from four hundred cities telling method of collection, cost, number of collections per week, point from which garbage pail is taken by collectors, and whether the collection service is considered satisfactory by the municipal official who furnished the information. The last of several tables on garbage disposal, the first two of which were published in the December issue.

GARBAGE COLLECTION

NOTE: The following arbitrary meanings have been assigned to terms in this table: Municipal—by men paid by the city by the day or month. Contract—performed by private party or parties, who are paid by the city. Private—performed by private party or parties, who are paid by the householder, but at a rate determined by contract with the city. Individual—performed by the householder or by anyone with whom he may make arrangements, the city taking no part, unless to require that collectors take out licenses.

City	By What Method	Cost of Collection			Number of Collections Per Week In		Receptacles Collected From	Satisfactory? Remarks
		Paid By	Per Year Amount	Per	Summer	Winter		
Alabama:								
Fairfield	Municipal	City	$3.1488	Family	6 & 2	6 & 2	.....	Very satisfactory
Mobile	Municipal	.....	.....	.....	6	6	Curb	Yes
Selma	Municipal	.....	.....	.....	..	..	.....	.....
Talladega	Contract	City	1,560.00	.....	1	1	Curb or back door	Backdoor coll. too exp.
Arizona:								
Clifton	Municipal	.....	.....	.....	6 & 2	6 & 2	Curb or back door	Satisfactory
Miami	Municipal	City	7,000.00	.....	7	7	Curb	Satisfactory
Tucson	Municipal	.....	.....	.....	..	..	.....	.....
Arkansas:								
Helena	Private	Tenants	26.00	Residence	6 & 3	6 & 3	Curb and alley	Satisfactory
California:								
Alameda	Private	Tenants	6.00	Residence	1	1	.....	.....
Glendale	Municipal	Tenants	4.00	Residence	..	..	.....	.....
Long Beach	Municipal	City	4.50	Ton	..	..	.....	.....
Marysville	Private	Tenants	9.00	Residence	3	3	Back door	Satisfactory
Monrovia	Contract	City	$40.00	.....	2	2	Curb or alley	Satisfactory
Napa	Private	Tenant	6.00	Residence	1	1	.....	Charges too high
Oakland	Private	Tenant	6.00	Residence	1	1	.....	Satisfactory
Ontario	Resid., munici.; busi., individ. with licensed collectors	.....	.....	.....	6 & 2	6 & 2	Alley	Satisfactory
Petaluma	Individual, unlicensed	Tenant	.....	.....	2	2	Back door	Satisfactory
Richmond	Private; pay city $50 yr. for 5 yrs.	Tenant	4.20 to 6.00	Residence	1	1	Back door	Satisfactory
Sacramento	Municipal	Tenant	6.00	Residence	1	1	.....	.....
San Bernardino	Private; licensed collectors	.....	Nothing	.....	2	1	Back door or curb	Satisfactory
San Gabriel	Individual; licensed collectors	.....	.....	.....	..	..	.....	No
Santa Ana	Municipal	City	7,000.00	.....	2	2	Curb	Yes
Santa Barbara	Individual; licensed collectors	.....	.....	.....	..	..	Back door	No; collectors too independent
So. Pasadena	Municipal	.....	.....	.....	2	2	Back door	Yes
Stockton	Individual	Tenant	9.00	Residence	..	..	.....	Coll. under no control
Upland	Individual	Tenant	12.00	.....	2	2	.....	Collections irregular
Colorado:								
Denver	Individual; licensed collectors	Tenant	.....	.....	3 to 6	2 to 6	Alley	Yes
Fort Collins	Contract	.....	Nothing	.....	6	6	Back door	Yes
Greeley	Individual; unlicensed	.....	.....	.....	3	3	Back door	Yes
Salida	Individual; licensed collectors	.....	.....	.....	..	..	.....	.....
Connecticut:								
Bridgeport	Municipal	City	3.41	Ton	1	1	Back door	Total cost, $47,197
Bristol	Municipal	City	5,986.00	.....	2	1	.....	.....
Hartford	Municipal and licensed farmers	City	3.39	Cu. Yd.	6 & 2	6 & 2	Back door	Yes; some coll. pd. $300 a year
Middletown	Municipal	City	14,000.00	.....	2	2	Curb	Yes

GARBAGE COLLECTION—Continued

City	By What Method	Cost of Collection: Paid By	Cost of Collection: Per Year Amount	Cost of Collection: Per	Number of Collections Per Week In: Summer	Number of Collections Per Week In: Winter	Receptacles Collected From	Satisfactory? Remarks
Connecticut (Contd)								
New Britain	Contract	City	8,000.00	.....	2	1	Back door	Collections often irreg.
New Haven	Municipal and contract	City	40,000.00	.....	2	2	Back door	Yes
New London	Municipal	City	8,000.00	.....	2, 3 or 6	2	Back door	Fairly so
So. Manchester	Individual	Tenant	.....	.....	..	..	.....	Yes
Stratford	Individual	Tenant	.....	.....	..	..	.....	.....
Willimantic	Contract	City	2,500.00	.....	4	2	Curb	Yes
Dist. of Columbia:								
Washington	Municipal	.....	.....	.....	6	3	Alley	Yes
Florida:								
Clearwater	Municipal	City	7,200.00	.....	..	..	.....	Yes
Fort Myers	Municipal	.....	4,200.00	.....	2	2	.....	.....
Gainesville	Municipal	.....	.....	.....	..	..	.....	.....
Jacksonville	Municipal	.....	.....	.....	..	..	.....	.....
Sanford	Municipal	.....	.....	.....	3	3	Alley	Yes
Georgia:								
Albany	Municipal and unlicensed	City	15,000.00	.....	6	6	Rear	Yes
Griffin	Municipal	.....	.....	.....	..	..	.....	.....
La Grange	Municipal	.....	.....	.....	6	6	Curb	No
Rome	Municipal*	.....	.....	.....	7	7	Curb	Yes
Idaho:								
Boise City	2 contractors pay city $406	.....	.....	.....	6 & 3	6 & 2	.....	.....
Caldwell	Individual unlicensed	Tenant	.....	.....	..	..	.....	.....
Pocatello	Contract	City	6,552.00	.....	1	1	Alley	Yes
Illinois:								
Blue Island	Individual, unlicensed	Tenant	.....	.....	2	2	Curb and alley	Yes
Canton	Individual, unlicensed	Tenant	.....	.....	..	..	.....	.....
Champaign	Private	Tenant	18.00	.....	2	2	.....	.....
Chicago	Municipal; hotels, individual, licensed	Tenant	.....	.....	3	2	Curb and back door	Yes
Chicago Heights	Municipal	City	4,000.00†	.....	..	..	.....	.....
East Moline	Contract	City	5,000.00†	.....	..	..	.....	Yes
Evanston	Municipal	City	1.05	Cu. Yd.	2 or 3	2 or 3	.....	Yes
Galesburg	Municipal	City	14,000.00	.....	2	1	Back door	Yes
Glencoe	Municipal	Tenant	14.00 to 54.00	Residence	3	3	.....	Returns about pay cost
Kewanee	Municipal	City	1,576.00	.....	..	..	.....	.....
Marion	Private, licensed	Tenant	.....	.....	Irregular	..	.....	No
Murphysboro	Municipal	City	3,000.00	.....	6	6	.....	Yes
Oak Park	Municipal	.....	.....	.....	2	2	Alley	Yes
Quincy	Contract	City	12,400.00	.....	Irregular	..	.....	No
Indiana:								
Anderson	Municipal and individual, unlicensed	.....	.....	.....	2	1	Back door	No
Bedford	Contract	City	1,100.00	.....	2	2	Back door	Yes
Brazil	Individual, unlicensed	.....	.....	.....	..	..	Back door	Yes
Columbus	Municipal	.....	.....	.....	3	2	Back door	Yes
Elwood	Municipal	Hotels, etc.	.07	Collection	..	..	Alley or back door	Cost city $4,511 in 1921
Fort Wayne	Contract	City	41,472.00§	.....	6 & 2	6 & 1	.....	.....
Lafayette	Municipal	City	7,762.00§	.....	2	1	.....	.....
Lebanon	Contract	City	1,800.00	.....	2	1	Back door	Yes
Mishawaka	Municipal	.....	.....	.....	2	1	Alley	Yes
Peru	Municipal and individual, unlicensed	.....	.....	.....	2	1	Alley	Yes
Portland	Contract	City	500.00	.....	..	..	.....	.....
Richmond	Municipal and individual, unlicensed	.....	.....	.....	..	1	Curb	Yes
Shelbyville	Contract	City	15,000.00	.....	2	1	Back door	Yes
South Bend	Municipal	.....	.....	.....	2	1	Alley	Yes
Terre Haute	Contract	.....	.....	.....	..	..	.....	Collections too infreq.
Valparaiso	Municipal	City	2,000.00	.....	4	2	.....	Yes
Wabash	Municipal	City	1,600.00	.....	1	1	Curb and alley	Yes; some object to carrying to curb
West Lafayette	Contract	.....	720.00	.....	..	..	.....	.....
Iowa:								
Cedar Rapids	Municipal	.....	14,783.00	.....	6	3	.....	.....
Charles City	Contract	.....	.....	.....	..	..	.....	.....
Creston	Individual	Tenant	0 to 12.00	Residence	..	..	.....	.....
Davenport	Municipal	City	25,000.00	.....	..	..	.....	Yes

Dubuque	Contract	City	12,000.00	.....	..	..	.....	No
Keokuk	Individual	Tenant	.....	.....	..	..	.....	.....
Marshalltown	Private, and individual unlicensed	Tenant	15.00	Residence	2	1	Back door	No
Mason City	Municipal	City	4,200.00	.....	2	2	Back door	Yes
Muscatine	Contract, 6 months only	.....	.....	.....	..	..	.....	.....
Red Oak	Individual, licensed	Tenant	.....	.....	6	3	Back door	Yes
Kansas:								
El Dorado	Private	Tenant	12.00	Residence	2	1	.....	Not entirely
Independence	Private	Tenant	12.00	Residence	2	2	.....	Yes
Salina	Individual, licensed	Tenant	18.00	Residence	6	2	Alleys	Yes
Kentucky:								
Ashland	Individual	.....	.....	.....	..	..	.....	No
Fort Thomas	Municipal	.....	.....	.....	6	6	Curb	Yes
Madisonville	Individual, unlicensed	.....	.....	.....	..	..	Back door	Collect, too infrequent
Paducah	Individual, unlicensed	.....	.....	.....	..	..	.....	No
Louisiana:								
New Orleans	Municipal*	City	3.00 to 4.00	Ton	6	6	.....	.....
Maine:								
Augusta	Individual	.....	.....	.....	..	..	.....	Yes
Oldtown	Individual, unlicensed	.....	.....	.....	..	..	.....	Yes
Maryland:								
Hagerstown	Contract	City	2,240.00	.....	3	2	Curb	Yes
Massachusetts:								
Adams	Municipal	.....	.....	.....	6	..	Back door	Yes
Athol	Individual, unlicensed	.....	.....	.....	2	1	Back door	No
Beverly	Contract	City	4,200.00	.....	..	..	.....	Yes
Brockton	Municipal	City	37,530.00	.....	6 & 1	6 & 1	.....	Twice a week in summer desirable
Cambridge	Municipal	City	80,000.00	.....	6 & 3	6 & 2	.....	.....
Concord	Private	.....	Nothing	.....	3	1	Back door	Fair
Dracut	Individual, unlicensed	.....	.....	.....	6	2	Back door	Yes
Fall River	Contract	City	79,000.00	.....	..	..	.....	Yes
Fitchburg	Contract	.....	.....	.....	..	..	.....	.....
Greenfield	Contract	City	3,000.00	.....	..	..	.....	.....
Haverhill	Contract	City	13,500.00	.....	1	1	Curb or back door	Fairly
Holyoke	Contract	City	8,200.00	.....	3	2	Back door	Yes
Hudson	Private	.....	.....	.....	4	1	Back door	No
Ludlow	Contract	City	5,500.00	.....	3	2	Back door	Yes
Lynn	Municipal	City	.....	.....	..	..	.....	.....
Malden	Municipal	.....	.....	.....	2	1	Back yard	Yes
Medford	Municipal	City	15,000.00	.....	2	1	Back door	Yes
Middleboro	Private	.....	Nothing	.....	1	1	.....	.....
New Bedford	Municipal	.....	.....	.....	..	..	.....	Fairly
Newburyport	Individual, unlicensed	.....	.....	.....	4	2	Back door	Yes
Newton	Contract	City	31,300.00	.....	3	2	Back door	Yes
North Adams	Contract	City	3,150.00	.....	..	..	.....	Fairly; collections sometimes slighted
Orange	Contract	City	300.00	.....	1	1	.....	Yes
Peabody	Municipal	.....	.....	.....	..	..	.....	Last year by farmers
Rockland	Individual, unlicensed	.....	.....	.....	..	..	Back yard	.....
Waltham	Municipal	City	15,500.00	.....	..	..	.....	Until recently contract very unsatisfactory
Watertown	Contract	City	8,000.00	.....	2	2	Back door	Yes
Winchester	Municipal	.....	.....	.....	3	2	Back door	Yes
Worcester	Municipal and individual	City	0.355	Capita	..	..	.....	Will stop individual collections
Michigan:								
Alma	Contract	City	2,200.00	.....	6	2	Back door	Yes
Ann Arbor	Contract	City	16,000.00	.....	3	2	Back door	Yes
Detroit	Municipal	City	5.59	Ton	..	..	.....	.....
Flint	Municipal	City	75,952.00	.....	2	1	Back door	Yes
Highland Park	Municipal	.....	.....	.....	2	2	Alley	Yes
Holland	Private	Tenant	.07	Can	1	1	Back door	Fair
Ishpeming	Municipal	.....	.....	.....	6	3	Back door	Yes
Jackson	Private	Tenant	4.80	Residence	2	2	Back door	Yes
Kalamazoo	Private	Tenant	12.00	Residence	2	2	Back door	Yes
Lansing	Municipal	City	40,000.00	.....	2	2	Back door	Yes
Ludington	Municipal	.....	.....	.....	2	None	Curb	Yes
Monroe	Municipal and unlicensed	.....	.....	.....	2	1	Curb	No
Muskegon	Municipal and unlicensed	.....	.....	.....	2	2	Curb	Yes
Niles	Individual, licensed	Tenant	12.00	Residence	..	..	Door	No
Owosso	Private	Tenant	12.00	Residence	3	2	.....	Yes
Pontiac	Contract	City	12,500.00‡	.....	6 & 2	6 & 2	Back door	Fair
Sturgis	Contract	City	1,600.00	.....	2	1	Back door	Yes

GARBAGE COLLECTION—Continued

City	By What Method	Cost of Collection: Paid By	Cost of Collection: Per Year Amount	Cost of Collection: Per	Number of Collections Per Week in: Summer	Number of Collections Per Week in: Winter	Receptacles Collected From	Satisfactory? Remarks
Minnesota:								
Austin	Private	.....	.....	.....	2	2	Back door	Yes
Brainerd	Individual	Tenant	14.00	Residence	..	..	.....	.....
Ely	Municipal	City	2,808.00	.....	6 & 3	6 & 3	.....	Very
Fairmont	Individual	Tenant	18.00†	Residence	..	..	.....	.....
Minneapolis	Municipal	Tenant	2.60	Residence	..	..	.....	.....
Rochester	Municipal	City	3,500.00	.....	3	1	Back door	Not entirely
St. Paul	Municipal	.....	.....	.....	2	1	Back door	Equipment antiquated
Mississippi:								
Natchez	Municipal	City	4,000.00	.....	..	..	.....	.....
Vicksburg	Municipal	.....	.....	.....	..	..	Curb	Yes
Missouri:								
Cape Girardeau	Individual, licensed and unlicensed	Tenant	.....	.....	..	..	Back door	Yes
Columbia	Individual, licensed	Tenant	.....	.....	..	..	Back door	No
Joplin	Private	.....	Nothing	.....	..	..	.....	.....
Sedalia	Individual, unlicensed	Tenant	.....	.....	3	1	Back door	No, should be municipal
Montana:								
Havre	Private	Tenant	1.35	Residence	..	..	.....	.....
Kalispell	Municipal	.....	.....	.....	1.3	1	Curb	Yes
Nebraska:								
Fremont	Private	Tenant	9.00	Residence	1	1	.....	Yes
Hastings	Private**	Tenants	24.00	Residence	3	1	Back door	Yes
Lincoln	Private	Tenants	3.60*	.....	..	..	.....	.....
Omaha	Contract	City	79,000.00	.....	..	..	.....	.....
New Hampshire:								
Franklin	Individual, unlicensed	.....	.....	.....	1	1	Curb	Yes
Nashua	Contract and individual, licensed	City	600.00	.....	2	1	Back door	No—no garbage ordinance
New Jersey:								
Asbury Park	Contract	City	29,000.00	.....	6	6	Back door	Yes
Atlantic City	Contract	City	139,900.00	.....	6	3	Back door	Yes
Bergenfield	Municipal	City	1,800.00†	.....	..	..	.....	.....
Freehold	Contract	City	3,150.00	.....	..	..	.....	.....
Hackensack	Municipal	City	36,000.00	.....	2	2	Cellar or back door	Yes
Irvington	Municipal	City	0.50††	Capita	6 & 3	6 & 3	.....	.....
Montclair	Municipal	City	30,000.00	.....	3	2	Back door	Yes
Newark	Municipal	.....	.....	.....	3	2	Back door	Yes
New Brunswick	Municipal, some by farmers	City	8,242.00	.....	2	1	.....	.....
Paterson	Municipal	City	0.64	Cu. Yd.	..	..	.....	Yes
Phillipsburg	Contract and individual, unlicensed	City	12,000.00	.....	2	2	Curb	Fairly so
Rahway	Municipal	City	6,800.00	.....	1	1	.....	.....
Roselle Park	Municipal	.....	.....	.....	2	1	Curb	Yes
Spring Lake	Contract	City	.....	.....	..	..	.....	.....
Summit	Contract	City	29,400.00	.....	3	3	Cellar	Fairly so
Westfield	Private	Tenant	18.00	.....	2	2	Back door	Yes
New York:								
Albany	Business dist., contract	City	4,700.00	.....	..	..	.....	.....
	Rest of city, individual, licensed	.....	Nothing	.....	..	..	.....	.....
Amsterdam	Contract	City	28,000.00	.....	2	2	Back door	Yes
Auburn	Contract	City	24,000.00	.....	2	1	Back door	Yes
Buffalo	Municipal	City	2.15	Cu. Yd.	2	1	Back door	Yes
Carthage	Individual	Tenant	6.00	Residence	..	..	.....	No; three-fourths of householders do not have it removed
Cortland	Contract	City	4,650.00	.....	3	2	Back door	Yes
Glens Falls	Individual	.....	Nothing	.....	..	..	.....	No; collections irregular and uncertain
Gloversville	Contract	.....	.....	.....	..	..	.....	Yes
Hempstead	Municipal	.....	.....	.....	2	2	Curb	Yes
Herkimer	Contract	.....	.....	.....	..	..	.....	Yes
Howell	Private	Tenant	10.20	Residence	1	1	.....	.....
Hudson	Contract	City	2,200.00	.....	..	..	.....	Yes

Johnson City	Individual, licensed	.....	.....	.....	3	2	Back door	.....
Kingston	Municipal	.....	.....	.....	..	..	Curb	Yes
Little Falls	Contract	City	3,000.00	.....	2	2	Back door	.....
Mineola	Contract	City	2,500.00*	.....	..	..	.....	.....
New York (Manhattan, Brooklyn & Bronx Boros.)	Municipal; commercial garbage by licensed collectors	City	1.65	Ton	6	6	House line	Yes
Niagara Falls	Municipal	City	135,580.00*	.....	6 & 2	6 & 2	.....	.....
Oneida	Individual	Tenant	39.00	Residence	..	..	.....	Yes
Ossining	Municipal	City	12,500.00	.....	..	..	Back door	No; collection from curb preferred
Oswego	Individual	Tenant	5.20	Residence	1	1	.....	No; uncertain, unsanitary, expensive
Poughkeepsie	Contract	City	30,000.00††	.....	..	..	.....	.....
Rockville Center	Contract	City	2,000.00	.....	3	2	Back door	Yes
Saratoga	Individual, licensed	.....	.....	.....	..	..	.....	.....
Schenectady	Municipal	City	172,000.00††	.....	..	..	Back door and cellar	.....
Syracuse	Municipal	City	245,000.00†	.....	..	..	.....	.....
Tarrytown	Contract	City	7,250.00†	.....	2	2	100 ft. from curb	Yes
Utica	Municipal	.....	.....	.....	2	2	Back door	Yes
Watervliet	Contract	City	6,600.00	.....	3	2	Curb	Yes
North Carolina:								
Durham	Municipal	.....	.....	.....	3	2	Back door	Yes
Elizabeth	Individual, licensed	.....	.....	.....	..	..	Curb	No
Fayetteville	Individual, unlicensed, and municipal	.....	.....	.....	6	6	Back door and curb	Yes
Goldsboro	Municipal	City	1.90	Ton	2	2	Curb	.....
Greensboro	Municipal	City	7,000.00	.....	3	3	Back door and curb	Yes
Henderson	Municipal	.....	.....	.....	3	2	Curb	.....
Wilmington	Municipal	.....	.....	.....	3	3	Back door	.....
North Dakota:								
Bismarck	Contract	City	2,000.00	.....	..	..	.....	.....
Fargo	Individual	Tenant	12.00	Residence	1	1	.....	.....
Jamestown	Individual, unlicensed	Tenant	8.00	Residence	6	6	Back door	Fairly so
Mandan	Municipal	City	425.00	.....	..	..	.....	.....
Valley City	Municipal May to Nov.; individual Nov. to May	City	1,500.00	.....	..	..	.....	.....
Washburn	Individual	.....	.....	.....	..	..	.....	.....
Ohio:								
Akron	Municipal and individual, unlicensed	City	130,000.00	.....	2	1	Back door	Back door coll. too exp.
Alliance	Private	Tenant	0.15	10-gal. Can	..	..	.....	Yes
Ashland	Municipal and individual, unlicensed	City	2,400.00	.....	3	2	Door	Yes
Ashtabula	Private	Tenant	0.10	Bushel	1	1	Back door	Partially
Bellefontaine	Individual, unlicensed	.....	.....	.....	..	..	Back door	Yes
Bucyrus	Municipal and individual, unlicensed	City	2,000.00†	.....	2	1	Curb	Yes
Canton	Municipal	.....	.....	.....	..	..	.....	Yes
Chillicothe	Municipal	City	7,000.00	.....	3	2	Curb	Yes
Cincinnati	Contract	City	202,500.00	.....	2	2	Back door and curb	Yes
Columbus	Municipal	City	0.35	Capita	..	..	.....	Yes
Dayton	Municipal	.....	.....	.....	1	1	Back door and curb	Yes
Delaware	Individual, unlicensed	Tenant	.10 to .15	Can	..	..	Back door	Yes
Elyria	Contract	City	8,280.00	.....	..	..	.....	Yes
Fostoria	Municipal	Tenant	.25 to 2.00	Collection	..	..	.....	Yes
Fremont	Municipal	City	2,700.00	.....	6	2	Back	Yes
Galion	Individual, unlicensed	.....	.....	.....	..	..	Back door	No
Newark	Individual, licensed	.....	.....	.....	2	1	Back door	Yes
Portsmouth	Municipal	.....	.....	.....	2	2	Back door	Yes
Urbana	Private	Tenant	0.25	Collection	3	1	Back door	Yes
Van Wert	Individual	Tenant	.....	.....	6	6	.....	.....
Wilmington	Individual	.....	.....	.....	..	..	Back door	.....
Wooster	Private	Tenant	6.00	Residence	..	..	.....	Yes
Youngstown	Contract	.....	.....	.....	..	..	.....	Yes
Janesville	Municipal	City	5,300.00§§	.....	..	..	.....	Fairly so
Oklahoma:								
Ada	Private	Tenant	4.00	Residence	2	1	Alley	Fair; alleys dirty
Blackwell	Individual, licensed	.....	.....	.....	2	1	Alley	Yes
Enid	Private	Tenant	3.00	Residence	2	1	Back door and curb	Partly
McAlester	Private	Tenant	.....	.....	..	..	.....	Fairly so
Oklahoma City	Municipal; commercial by contract	Tenant	6.00 to 12.00	Residence	..	..	.....	.....

GARBAGE COLLECTION—Continued

City	By What Method	Cost of Collection Per Year: Paid By	Cost of Collection Per Year: Amount	Cost of Collection Per Year: Per	Number of Collections Per Week In: Summer	Number of Collections Per Week In: Winter	Receptacles Collected From	Satisfactory? Remarks
Oregon:								
Astoria	Private	Tenant	18.00	Residence				Yes
Klamath Falls	Private	Tenant	0.35 up	Collection				No
La Grande	Contract and individual, unlicensed	Tenant	0.50	Collection	3	1	Back door	No
Pendleton	Individual, licensed				6	6	Back door and curb	
Pennsylvania:								
Altoona	Municipal	City	18,867.00§§		3	1		Yes
Beaver Falls	Municipal				3	1	Back door	Yes
Berwick	Individual	Tenant	0.66*	Residence			Curb, $1 more if at door	
Bethlehem	Individual	Tenant	7.80 to 9.20	Residence				
Bloomsburg	Private and individ., licensed & not						Back door	Yes
Braddock	Municipal							Yes
Carlisle	Contract	City	3,000.00		2	2	Back door and curb	Yes
Clairton	Municipal							
Coatesville	Contract and individual, unlicensed	City	6,364.00		3	2	Back door	Yes
Duquesne	Contract	City	10,000.00		1	1	Back door	No, municipal better
DuBois	Contract and private	City, Tenant	1,500.00 & .04	Total, resid	1	1	Curb	No, people won't pay
Duquesne	Individual	Tenant	10.20	Residence				No
Easton	Municipal				3	1	Curb	Yes
Ellwood	Municipal	Tenant	6.00	First floor			Back door	Not self supporting
Erie	Municipal	City	3.11	Ton				
Franklin	Individual	Tenant	5.00	Residence				
Freeland	Individual, licensed and unlicensed				6	6	Back door	Yes
Greenville	Private	Tenant	9.00	Residence	3	2	Back	Yes
Kittanning	Contract and individ., unlicensed	City	350.00		1	1	Back door and curb	Yes
Lebanon	Individual, unlicensed				1	1	Back	Licensing desirable
Lewistown	Individual, unlicensed						Back door	No
Meadville	Contract	City	36,000.00		3	1	Back door	Very
New Brighton	Individual, unlicensed				1	2	Back door	No
North Braddock	Municipal				3	3	Rear yard	Yes
Parkesburg	Municipal	City	770.00*		1	1		Fairly so
Pittston	Contract	City	13,000.00		6	1	Back door or curb	Yes
Pottsville	Individual							No
Rankin	Municipal		0.85§§	Capita	3	3	Back door	Yes
Summit Hill	Contract	City	2,000.00				Yards	Yes
W. Pittston	Private and individ., unlicensed						Back	Yes
Wilkinsburg	Contract	City	31,000.00					
Rhode Island:								
Newport	Contract	City	19,250.00					
Providence	Contract	City	100,000.00					
South Carolina:								
Charleston	Municipal	City	72,480.00					
Chester	Municipal	City	10.10 per day					
Spartanburg	Private, licensed and unlicensed	Tenant			6	6	Back door and curb	Yes
South Dakota:								
Winner	Individual	Tenant					Cans	
Tennessee:								
Cleveland	Individual, unlicensed	Tenant						Not ideal
Johnson City	Individual, unlicensed	Tenant						No
Memphis	Municipal	City	100,068.00		3	1	Back door	Yes
Morristown	Individual, unlicensed	Tenant			6	4	Curb	No, not thorough
Texas:								
Amarillo	Individual	Tenant						No—city will collect garbage after complet of Incinerator
Beaumont	Municipal	City	$3,000 per mo. incl. incinerator		3	3	Curb	Yes
Dallas	Municipal				2	2	Back door	Yes
Denton	Individual	Tenant	6.00 to 12.00	Family				
Eagle Pass	Individual, unlicensed				6	6	Curb and alley	Yes and no—not to householder as yard is left dirty
Galveston	Municipal	City	57,880.11 yr	City				Yes
McKinney	Individual	Tenant						No change contemplated

Mineral Wells.....	Private	Tenant	No record	.....	..	..	.....	No—probable disease germs
Navasota	Individual, unlicensed	Tenant	?	?	?	?	Back door and curb	No—no system—city intends taking over collection
Utah:								
Brigham	Individual, unlicensed	Tenant	.....	.....	Not regular		Back door	No—no organized meth.
Logan City	Municipal (city limits); individual outside	City-Tenant	$5.00 per day	City	6	6	Boxes	.....
Ogden	Contractor	City	Ap. $11,000 yr.	City	..	..	.....	Very
Vermont:								
Barre	Individual, unlicensed	None	.....	.....	..	..	.....	.....
Bennington	Individual, unlicensed	.....	.....	.....	..	..	Back door	No—tenants hire own carts
Burlington	Municipal	City	.....	.....	3	2	Back door	No—collector objects going upstairs to apt. on higher floors
Rutland	Individual, unlicensed	.....	.....	.....	..	..	No	.....
Virginia:								
Bristol	Individual, unlicensed	Tenant	.....	.....	..	..	.....	.....
Danville	Municipal	City	25,000.00 yr.	City	6 & 2	6 & 2	Back door	No
Fredericksburg ...	Individual, unlicensed	Tenant	.....	.....	Irregular		Back door	No—contemplats municipal contract
Lynchburg	Municipal	City	.....	.....	2	2	Curb	Yes
Newport News	Municipal	City	.....	.....	3½	3½	Curb and back door	Yes
Norfolk	Municipal	City	.....	.....	6 & 3	6 & 3	.....	.....
Petersburg	Municipal	City	.....	.....	3	3	Curb	Yes
Portsmouth	Municipal	City	.....	.....	..	..	.....	Fairly—summer no—odors bad
Richmond	Municipal (few individual)	City (few Ten.)	.....	.....	3	3	.....	.....
Roanoke	Individual, unlicensed	.....	.....	.....	2	1	Alley	Yes
Washington:								
Aberdeen	Contractor	City	Contr. parts city, part receipts		..	..	.....	.....
Chehalis	Private	Tenant	{ 18.00-2.50 yr. Fixed by ordinance }	Tenant }	..	..	.....	Fairly
Seattle	Municipal and contract	City & Contr.	534,100.00	.....	..	..	.....	.....
Spokane	Municipal	Tenant	.....	.....	..	..	.....	Agitation for free col.
Walla Walla	Contractor	City	1,200.00	.....	1	1	Either	Yes
West Virginia:								
Bluefield	Individual	Tenant	.....	.....	..	..	.....	No—unsystematic
Clarksburg	Individual, unlicensed	Tenant	$6 per tenant	.....	1	1	Back door	Yes
Huntington	Contractor	City	22,900.00	.....	1 & 2	1 & 2	Back door	Yes
Parkersburg	Contractor	City	7,400.00	.....	..	..	.....	Fairly—insufficient equipment
Wisconsin:								
Appleton	Individual	Tenant	.....	.....	..	..	.....	.....
Ashland	Contractor	City	1,000.00	.....	2	..	Back door	Yes
Baraboo	Individual	Tenant	$10	Family	..	..	.....	.....
Beaver Dam	Individual, unlicensed	Tenant	$6	Family	3	2	Back door	No
Fond du Lac.....	Municipal	Tenant	$3 per can	Family	2	1	.....	.....
Green Bay	Municipal	City	No fig. yet	City	..	..	.....	Yes
Janesville	Contractor	City	7,000.00	City	6-3-2	1	Rear	.....
Kenosha	Municipal	City	$1 per yr.	Per capita	..	..	.....	Yes
Lake Geneva	Municipal	Tenant	$6-$12 per yr.	Per family	Irregular		.....	No—unsanitary, fire danger, etc.
Menasha	Individual, unlicensed	Tenant	.....	.....	..	..	Back door	Yes
Milwaukee	Municipal	City	.....	.....	..	..	.....	.....
Racine	Municipal	City	$5.22 per yr.	Per ton	2	2	Back door	Yes
Sheboyan	Municipal	City	.....	.....	2	2	Back door	Yes
Shorewood	Contract	Tenant	$6 per yr.	Per family	2 & 1	none	.....	.....
Wisconsin Rapids..	Municipal	City	$0.72½ per yr.	Per family	2	2	Back door and curb	Yes
Wyoming:								
Cheyenne	Municipal	City	.....	.....	..	..	Back door and curb	No—separate coll. of garbage and ashes (now placed in same wagon)
Sheridan	Individual, unlicensed and licensed	Tenant	.....	.....	..	..	.....	No—price charged exorbitant

*Combined refuse. †Includes rubbish and ashes. §Includes cans, bottles, etc.
‡ Includes two annual collections of ashes and rubbish. •• City receives one-half of all collector gets over a guaranteed minimum of $150 a month.
†† Includes ashes.
§§Includes disposal.

CONCRETE PAVEMENTS LAID IN 1922

City.	Concrete Reinforced Area	Concrete Reinforced Cost	Concrete Not Reinforced Area	Concrete Not Reinforced Cost
Alabama:	Sq. Yds.		Sq. Yds.	
Birmingham	.....	.....	11,553	$22,534.00
California:				
Santa Ana	35,346	$119,300[c]	.....	.....
Santa Barbara	.....	.....	16,967	.27
Vallejo	.....	.....	700	1.80[g]
Visalia	.....	.....	1,088	3,272.00[i]
Whittier	.....	.....	136,243	2.00[a]
Colorado:				
Fort Collins	50,192	$128,521.00[a]	.....	.....
Pueblo	.....	.....	16,328	29,451.00
Connecticut:				
Bridgeport	.....	.....	30,000	75,000.00[d]
New London	1,156	.....	5,170	.....
New Haven	7,000	.....	71,265	$167,400.00[i]
Wallingford	.....	.....	7,000	.....
Delaware:				
Wilmington	.....	.....	823	.....
District of Columbia:				
Washington	.....	.....	25,000	1.87
Georgia:				
Americus	5,589	1.64	.....	.....
La Grange	.....	.....	40 mi.	2.63
Macon	.....	.....	3,050	1.60
Illinois:				
Benton	17,700	89,000.00[e]	.....	.....
Carterville	.....	.....	39,313	3.08[a]
Centralia	58,855	.....	.....	.....
Champaign	46,000	178,000.00[f]	.....	.....
Chicago	.....	.....	455,190	.....
Chicago Heights	10,000	23,400.00	5,000	11,100.00
DeKalb	3,000	10,000.00	.....	.....
East Moline	34,375	119,367.00[i]	.....	.....
East St. Louis	43,300	168,700.00[g]	.....	.....
Edwardsville	.....	.....	1,610	5,000.00[g]
Glencoe	2,000	10,000.00	.....	.....
Granite City	42,000	2.83	.....	.....
Highland Park	20,000	70,000.00	.....	.....
La Grange	14,000	60,000.00[i]	.....	.....
Mattoon	5,000	2.50[a]	.....	.....
Marion	850	2.98[a]	.....	.....
Moline	55,570	1.98	.....	.....
Monmouth	3,892	2.50	.....	.....
Normal	11,160	38,570.00[i]	.....	.....
Oak Park	.....	.....	52,345	170,336.00[e]
Pana	3,764	2.85[a]	.....	.....
Quincy	.....	.....	478	1,463.00[d]
Riverside	27,800	109,175.00	.....	.....
Robinson	15,000	.....	.....	.....
Rockford	3.01 mi.	160,787.00	.....	.....
Waukegan	14,557	55,444.00[i]	.....	.....
Winnetka	1,700	9,000.00	.....	.....
Indiana:				
Anderson	.....	.....	13,571	33,700.00[g]
Boonville	9,000	2.25[i]	.....	.....
Elwood	.....	.....	26,160	52,000.00[g]
Fort Wayne	1,132	433,716.00[i]	.....	.....
Frankfort	833⅓	3,017.00[g]	.....	.....

CONCRETE PAVEMENTS—Continued

City.	Concrete Reinforced Area	Concrete Reinforced Cost	Concrete Not Reinforced Area	Concrete Not Reinforced Cost
Mississippi:	Sq. Yds.		Sq. Yds.	
Hattiesburg	5,000	13,000.00[d]	.....	.....
Missouri:				
Boonville	.....	.....	12,000	1.50
Brookfield	7,000	2.66	.....	.....
Cape Girardeau	1,730[m]	2,650.00	8,575	17,195.00[g]
Carthage	.....	.....	86,346	2.60[d]
Hannibal	2,660	7,500.00[g]	.....	.....
Jefferson City	.....	.....	6,600	2.20
Kansas City	.....	.....	9.0 mi.	351,847.00[a]
Maplewood	20,842	76,600.00[g]	.....	.....
Poplar Bluff	40,000	2.62	30,000	2.50
St. Louis	9,297	42,937.00[g]	.....	.....
Sedalia	.....	.....	44,516	101,291.00[d]
Springfield	3,000	2.20	15,000	2.05
Montana:				
Billings	.....	.....	1,702	2.24[a]
Glendive	32,520	118,337.00	.....	.....
Great Falls	12,063	40,700.00	1,556	4,080.00[p]
Lewiston	1,290	4,022.00[a]	.....	.....
Livingston	12,100	34,712.00[e]	.....	.....
Nebraska:				
Chadron	.....	.....	4,000	2.64
Fremont	22,415	2.08[i]	.....	.....
Lincoln	.....	.....	3,348.2	2.38[i]
Omaha	.....	.....	8,490	20,123.00[d]
New Hampshire:				
Berlin	857.8	3.00	.....	.....
Nashua	.....	.....	11,281	2.54[n]
New Jersey:				
Bridgeton	.....	.....	40,000	1.80[a]
Camden	.....	.....	0.11 mi.	3.20
Cape May	23,777	2.19[d]	.....	.....
Edgewater	21,685	108,425.00	.....	.....
Freehold	10,000	2.87[a]	.....	.....
Irvington	150,000	.....	.....	.....
Newton	11,200	32,704.00	.....	.....
Phillipsburg	5,533	16,792.00	.....	.....
Ridgefield Park	15,600	2.80[g]	.....	.....
Trenton	8,000	.....	.....	.....
Wallington	9,606	.....	.....	.....
New Mexico:				
Santa Fe	.....	.....	45,000	.....
New York:				
Amsterdam	24,000	62,000.00[d]	.....	.....
Auburn	20,632	43,755.00[i]	.....	.....
Carthage	2,000	2.50	.....	.....
Cohoes	1,900	3.28[g]	.....	.....
Corning	23,849	102,289.00[g]	.....	.....
Elmira	14,075	3.60[d]	.....	.....
Endicott	.....	.....	4,000	3.50[d]
Gloversville	19,650	55,589.00[k]	.....	.....
Gouveneur	.....	.....	1,200 sq. ft	1.50[d]
Herkimer	5,500	30,000.00[p]	.....	.....
Johnstown	17,500	$2.67[a]	.....	.....
Lackawanna	1,200	4,200.00[e]	.....	.....
Little Falls	15,202	5.15[n]	.....	.....
Lockport	3 mi.	2.80[a]	.....	.....
Lynbrook	55,000	2.55[d]	.....	.....

Gary	10,496	46,303.00[b]	1,086	3,585.00[b]
Kendallville	23,000	2.36[d]	.....	.....
Portland	11,000	28,702.00[1]	.....	.....
Richmond	28,905	2.22[d]	6,133	2.02[d]
South Bend	.....	.....	11,739	32,262.00[p]
Terre Haute	.....	.....	2,567	6,550.00[d]
Winchester	1,400	2.70	.....	.....
Iowa:				
Albion	10,000	38,000.00	.....	.....
Cedar Rapids	.....	.....	10,213	32,334.00[1]
Clinton	19,000	2.64	.....	.....
Davenport	.....	.....	19,823[1]	38,977.00[g]
Decorah	18,000	55,000.00[k]	.....	.....
Keokuk	.....	.....	5,023	2.20[d]
Muscatine	.....	.....	34,729.9	99,831.00
Ottumwa	14,680	2.93	.....	.....
Sioux City	29,000	90,000.00	42,124	96,400.00
Kansas:				
Chanute	.....	.....	8,238	1.98[g]
Columbus	.....	.....	9,000	.....
Ft. Scott	.....	.....	10,000	2.45
Junction City	.....	.....	5,015	2.63
Kansas City	.....	.....	91,615.30	169,959.00[p]
Leavenworth	15,000	2.15	5,000	2.00
Parsons	.....	.....	800[1]	2.00
Topeka	.....	.....	16,474	1.90[a]
Wichita	17,099	58,245.00[k]	63,198	153,639.00[k]
Kentucky:				
Corbin	5,000	25,000.00[1]	.....	.....
Lexington	5,700	15,800.00[o]	.....	.....
Ludlow	2,444	2.25	.....	.....
Paducah	700	1,163.00	.....	.....
Maine:				
Bangor	10,367	2.58[d]	.....	.....
Portland	.....	.....	4,500	.....
Massachusetts:				
Brockton	5,670	3.50[d]	.....	.....
Greenfield	3,000	.....	.....	.....
Haverhill	2,310	$7,375.00	.....	.....
Lowell	8,032	.....	.....	.....
North Adams	11,413	1.73[e]	.....	.....
		2.15[a]		
Pittsfield	10,278	2.70[d]	.....	.....
Worcester	640.9	3.50[d]	.....	.....
Michigan:				
Ann Arbor	.....	.....	811	2.73[a]
Bay City	.....	.....	1,066	$4,780.00
Detroit	.....	.....	263,000	612,032.00[1]
Cadillac	.....	.....	9,850	.....
Grand Rapids	5 mi.	267,000.00[k]	.....	.....
Dowagiac	.....	.....	1,423	.....
Mt. Clemens	.....	.....	5,000	2.12[a]
Muskegon Heights	.....	.....	1,614 6″	1.98[a]
			20,157 8″	1.98[a]
Pontiac	7,040	2.10	.....	.....
Port Huron	48,737	160,436.00[d]	.....	.....
Minnesota:				
Brainerd	26,763	72,534.00[k]	.....	.....
Duluth	102,000	2.48[a]	.....	.....
Fairmont	9,927	23,000.00[a]	.....	.....
Little Falls	2 mi.	.....	.....	.....
Mankato	1,143.6	2,514.00	20,907	36,598.00
Minneapolis	.....	.....	8,763	31,684.00[d]
Rochester	.....	.....	6,000	2.20[1]
So. St. Paul	37,600	129,400.00[f]	.....	.....
Willmar	70,000	200,000.00	.....	.....
Massena	12,706	37,834.00[g]	.....	.....
Newburgh	3,600 ft.	.....	.....	.....
Niagara Falls	.....	.....	10,878	55,931.00[1]
Ogdensburg	7,800	2.78[a]	.....	.....
Oneonta	5,000	3.12	.....	.....
Port Chester	3,400	.....	.....	.....
Rochester	990	3.06	.....	.....
Schenectady	10,896	50,275.00[g]	.....	.....
Syracuse	.....	.....	7,430	$34,850.00
Waverly	474	1,040.00[k]	.....	.....
North Carolina:				
Ashville	.....	.....	1,857	2.33
Durham	3,130	5.90[q]	.....	.....
Greensboro	36,000	2.40[a]	3,900	2.08[a]
North Dakota:				
Grand Forks	38,524	.....	.....	.....
Ohio:				
Akron	1.56 mi.	{ 3.80[a]	.....	.....
		} 3.17[a]		
Bellaire	40,000	3.95[1]	1,060	.....
Bucyrus	1,200	3,400.00[1]	.....	.....
Cincinnati	10,726	2.49	.....	.....
Columbus	25,000	78,000.00[1]	.....	.....
Dayton	36,106	83,480.00[d]	.....	.....
Delaware	2,400	.....	.....	.....
Ironton	4,800	2.20	.....	.....
Lorain	68,600	114,600.00[g]	.....	.....
Newark	475	1,022.00[1]	.....	.....
Ravenna	2,000	3.00[a]	.....	.....
Tiffin	.....	.....	28,000	.....
Wooster	500	2.79[a]	.....	.....
Zanesville	.....	.....	860	2,390.00[1]
Oklahoma:				
Chickasha	10,498	28,347.00[a]	132.441	33,367.00[a]
Enid	.....	.....	37,203	2.78[a]
Muskogee	.....	.....	1,660	3.35[f]
Tulsa	.....	.....	4,900	5.00[1]
Oregon:				
Astoria	.....	.....	28,590	60,030.00[a]
Corvallis	.....	.....	3,000	.....
Eugene	.....	.....	16,000	2.20[a]
Marshfield	.....	.....	1,562	2.25[a]
Oregon City	1,500	2.80[a]	6,800	1.88[a]
Portland	.....	.....	137,533	299,902.00[1]
Salem	.....	.....	35,038	89,010.00
Pennsylvania:				
Allentown	5,445.38	16,011.00[d]	.....	.....
Altoona	59,437	217,225.00[g]	.....	.....
Bangor	.....	.....	10,000	30,000.00[d]
Blairsville	500	4.00[d]	.....	.....
Catasauqua	21,760	52,817.00[d]	.....	.....
Clairton	3,185	2.85[a]	.....	.....
College Hill	7,960	3.40[a]	.....	.....
Franklin	.....	.....	796.2	2.48
Harrisburg	.....	.....	409.82	1,145.00[d]
Huntingdon	1,300	3.70[d]	.....	.....
Lebanon	4,500	12,600.00[1]	.....	.....
Monongahela	552.56	2,044.00[g]	.....	.....
Munhall	4,029	15,975.00[f]	.....	.....
New Castle	0.494 mi.	29,883.00[d]	.....	.....
Northampton	516	2.76[a]	.....	.....
North East	7,200	3.15	.....	.....
Oil City	1,161	3.30[a]	.....	.....
Sewickley	.....	.....	409	2.99
Somerset	.....	.....	5,700	3.10[a]
Tyrone	2,000	3.17[d]	.....	.....

CONCRETE PAVEMENTS—Continued

City.	Concrete Reinforced Area	Cost	Concrete Not Reinforced Area	Cost
Rhode Island:				
Cranston	4,131	1.31	.....	.....
Woonsocket	.....	.....	8,950	3.60[1]
South Carolina:				
Greenville	.....	.....	25,183	57,921.00[1]
South Dakota:				
Mitchell	8,984	25,701.00[1]	.....	.....
Sioux Falls	25,000	57,000.00[1]	.....	.....
Tennessee:				
Cleveland	.....	.....	7,250	27,000.00[c]
Texas:				
Bonham	.....	.....	300	.....
Dallas	772.9	2,764.00[1]	.....	.....
San Benito	6,500	3.50[1]	.....	.....
Utah:				
Salt Lake City	.....	.....	1,647.0	2.10[a]
Vermont:				
Bennington	11,111.1 sq.yd.	12.00cu.yd.	.....	.....
Rutland	2,200	2.02[d]	.....	.....
Virginia:				
Danville	.....	.....	620	1,848.00[1]
Washington:				
Aberdeen	.....	.....	25,166	86,434.00[a]
Mt. Vernon	.....	.....	16,693	114,930.00[a]
Olympia	.....	.....	59,334.3	6", 1.70 7", 2.00 8", 2.25
Seattle	.....	.....	441,000	56,586.00[a]
Yakima	.....	.....	23,420	.....
West Virginia:				
Charleston	.....	.....	10,596	.....
Clarksburg	13,130	79,600.00[f]	.....	.....
Fairmont	6,209	20,506.00[d]	.....	.....
Wisconsin:				
Beloit	77,833	179,600.00[g]	.....	.....
Eau Claire	3,448	2.68	2,863	4,423.00
Green Bay	.....	.....	.....	.....
Janesville	27,231	79,400.00[d]	.....	.....
Lake Geneva	27,350	39,824.00[1]	.....	.....
Manitowoc	25,000	2.64[d]	.....	.....
Menomonie	12,600	2.29[a]	.....	.....
Oshkosh	657	1,899.00[d]	.....	.....
Sheboygan	54,213	116,685.00[d]	3,742	7,441.00[d]
Stevens Point	30,000	1.93[a]	.....	.....
Wausau	.....	.....	10,000	25,000.00[d]
Wisconsin Rapids	3,000 yd.	2.25[a]	17,000 yd.	2.14[a]
Wyoming:				
Casper	47,006	2.26[a]	.....	.....

[a]—Pavement only. [b]—Includes grading, curb and sidewalks. [c]—5" thick on old concrete base. [d]—Pavement and grading. [e]—Pavement, grading, curb and storm sewers. [f]—Includes curb drainage. [g]—Includes grading and curb. [h]—Entire cost, including engineering and inspection. [i]—Alleys. [m]—4" resurfacing. [n]—Includes grading and catch basins. [o]—Includes grading and underdrains. [q]—In car tracks. [r]—6" vibrolithic. [s]—Includes integral curb. [t]—Includes grading, curb, retaining walls and sewer repairs.

Paving Notes

Rockford, Illinois, relaid 1,854 square yards of creosoted wood block pavement at a cost of $9,628. This cost includes the tearing out of the old blocks and scraping pitch off of the plank on which the blocks rested. In laying the new blocks, a ⅛-inch fibre cushion and 1-inch sand cushion were used.

Portland, Maine.—A sidewalk ordinance was adopted with the idea of having the city pay one-half the cost of new sidewalks, the other half being assessed upon the abutting property. In the case of cement sidewalks the work is paid for by the property owner and he receives a rebate of 62½c. a square yard from the city. In the case of brick sidewalks the city furnishes the brick and sand and the abutting property pays the city for the labor and additional cost, including that of the curb.

In Camden, New Jersey, 1.67 miles of granite block pavement was relaid last year. The old block had been laid on a sand foundation and the new block was laid on an 8-inch concrete base. Some of the blocks were used as found, some were renapped, some old blocks were bought and some new blocks conforming to the modern specifications. The price paid for new modern specification blocks, including base, was $6.60. Old blocks laid on a new base cost $2.65. The modern specification blocks cost $135 per thousand, while old granite blocks were purchased at $35 per thousand. Recutting the old blocks, whether purchased or removed from the street, cost $13 per thousand.

In New Brunswick, New Jersey, last year, in seven contracts for sheet asphalt pavement on a 5-inch base, unit prices varied from $1.25 to $1.50 for excavation, $2.98 to $3.18 for pavement, including base, from 74c. to 95c. for 6-inch by 18-inch concrete curb. One asphalt block pavement on a 6-inch base cost $3.33 per square yard.

Fargo, North Dakota, last year paid for sheet asphalt pavement $2 per square yard for a 5-inch concrete base and $1.60 for a2-inch wearing surface. For brick pavement it paid $2.80 for 7-inch base and $2.85 for a 3-inch brick surface.

In Warren, Ohio, all asphalt used for repairing asphalt streets is hauled 17 miles from a mixing plant in another city.

Scranton, Pennsylvania, owns a 1,500-yard Cummer asphalt plant which it not only uses for repairing pavements, but also furnishes contractors with asphaltic mixtures for work done by them. In 1922 the price charged f. o. b. plant was 75c. per square yard for material for 1-inch binder and 2-inch surface.

BITUMINOUS PAVEMENTS

Other Than Sheet Asphalt and Asphalt Concrete

For Sheet Asphalt and Asphalt Concrete see the February Issue.

For Interpretation of Letters and for Foot Notes see Page 108.

		Area, Sq. Yd.	Cost
Alabama:			
Birmingham	W.B.	43,213	$110,540.00
California:			
Monterey	A.M.	100,000 ft.	.18
Oakland	T.M.	845,698	267,335.00
Santa Barbara	A.M.	300,000	.11
Santa Monica	T.M.	37,090	.....
South Pasadena	A.M.	11,000	1.00[c]
Visalia	W.B.	41,054	.....
Colorado:			
Pueblo	W.B.	235,807	542,204.00[b]
Connecticut:			
Bridgeport	T.M.	10,000	9,000.00[c]
	A.M.	130,000	116,000.00[c]
Greenwich	A.M.	9,206	$1.37-$1.44[a]
Middletown	A.M.	7,165	9,600.00[c]
Florida:			
Key West	A.M.	50,520	80,000.00[b]
Idaho:			
Boise	W.B.	16,337	1.98[b]
Illinois:			
Chicago	T.M.	35,288	.....
Danville	A.M.	1,450	2.66[b]
Joliet	T.M.	30,000	4,050.00[i]
Quincy	A.M.	120,890	109,300.00[d]
Rockford	T.M.	218 mi.	100.73
Waukegan	A.M.	1,160	3,943.00[f]
Indiana:			
Frankfort	R.A.	24,477 sq. ft.	2,734.00[a]
Huntington	T.M.	3,266 ft.	7,693.00
W. Lafayette	T.M.	700 lin. ft.	8.00 l. ft.
Iowa:			
Clinton	W.B.	29,000[r]	2.34[a]
Davenport	W.B.	129,132	463,412.00[d]
	W.B.	80,000[a]	180,363.00[d]
Kansas:			
Kansas City	W.B.	40,247	116,701.00[a]
	R.A.	91,679	300,892.00[a]
Parsons	T.M.	8,800	1.75
Kentucky:			
Bowling Green	R.A.	20,000	21,000.00
Lexington	A.C.	9,700	28,000[i]
	A.C.	14,500	79,000.00
Maine:			
Augusta	T.M.	1,778	2.70[c]
Lewiston	T.M.	1 mi.	.....
Maryland:			
Salisbury	T.M.	24,000	0.18[a]
Massachusetts:			
Brockton	A.M.	19,130	1.85[c]
Brookline	W.B.	7,553	2.94
	A.M.	15,000	1.25
	T.M.	15,000	1.25
	A.	14,301	.....
Fitchburg	A.M.	8,800	2.10
Haverhill	A.M.	7,727	11,170.00
Lexington	A.M.	25,000	2.56[f]
	T.C.	2,250	1.08[f]
Lowell	A.M.	20,518	.....
New Bedford	W.B.	84,628	2.09[c]
	T.M.	140,038	1.60[c]
Rockland	T.M.	5,575	20,390.00
Somerville	T.M.	4,117	7,543.00[c]
Waltham	A.M.	1,494	2,681.00[c]
	A.M.	15,808	30,933.00[f]
Webster	T.M.	1,333	1.35[c]
Worcester	T.M.	14,478	1.60[c]
Michigan:			
Benton Harbor	W.	80,000	1.32[a]
Holland	W.	25,100	79,335.00[k]
Ironwood	T.M.	24,000	2.68[m]
	T.M.	20,000	1.60
Mt. Clemens	W.	11,200	2.85[b]
Muskegon	T.M.	3,200	.....
Negaunee	T.M.	25,000	35,000.00[i]
Sault Ste Marie	W.B.	20,000	2.25[a]
	A.M.	6,000	3.25[b]
Minnesota:			
Duluth	W.B.	57,000	3.60[b]
Missouri:			
Hannibal	Asb.	8,705	19,500.00[a]
	T.M.	15,130	34,500.00[b]
Jefferson City	A.M.	24,000	1.10
Joplin	A.M.	18,343	$3,040.00
Kansas City	R.A.	0.05 mi.	2,975.00[b]
	A.M.	2.08 mi.	75,028.00[b]
St. Louis	W.B.	76,720	326,296.00[d]
	T.M.	11,000	59,363.00[d]
Sedalia	A.M.	16,253[r]	8,533.00[a]
Montana:			
Billings	W.B.	63,378	2.58[b]
Great Falls	W.B.	18,367	59,300.00[c]
Helena	W.B.	23,000	70,000.00[a]
New Hampshire:			
Laconia	A.M.	12,468	2.00[c]
Portsmouth	T.M.	10,000	38,000.00[b]

BITUMINOUS PAVEMENTS

		Area, Sq. Yd.	Cost
New Jersey:			
Bergenfield	T.M.	17,320	90,000.00[k]
East Orange	W.B.	39,354	$2.30-$3.50[c]
	Nat'l	40,690	$2.35-$3.30[c]
Edgewater	T.M.	1,505	2,500.00
Passaic	A.M.	2,724	42,480.00[d]
Plainfield	T.M.	4,450	.....
Rahway	T.M.	500	0.34
Rutherford	A.M.	¾ mi.	1.25[c]
South Orange	A.M.	7,180	12,743.00
	N.	5,507	19,098.00
Summit	A.M.	3,100[t]	0.98[a]
	T.M.	2,100	0.93
West Orange	W.B.	1,100	3.88[a]
	A.M.	10,807	1.90[a]
	T.M.	685	2.25[a]
	Nat'l	1,180	2.98[a]
New Mexico:			
Roswell	W.B.	56,000	2.42
New York:			
Amsterdam	A.M.	10,000	15,000.00[c]
Auburn	W.B.	47,500	116,200.00[k]
Binghampton	A.M.	1,975	7,000.00[i]
	W.B.	25,650	96,700.00[i]
Carthage	T.M.	3,500	1.50
Cohoes	W.B.	8,681	3.25[r]
Cortland	A.M.	6,000	1.20[d]
Elmira	W.B.	44,270	4.13[e]
Endicott	W.B.	400	3.65[e]
Johnson City	W.B.	1,040	3,348.00[b]
Johnstown	A.M.	1,300	2.19[b]
Kingston	W.	4,000	.....
	A.M.	11,356	.....
Lockport	W.	14,877	2.10[b]
Niagara Falls	W.B.	4,531	31,655.00[i]
No. Tonawanda	W.B.	28,338	110,050.00
Oneida	W.B.	23,442	95,232[d]
Poughkeepsie	W.B.	2,711	2.30
Rochester	W.B.	48,240	3.20[b]
	W.B.	25,500	2.43[a]
North Carolina:			
Durham	W.B.	33,400	2.99[b]
Oxford	W.B.	35,000	2.47[b]
North Dakota:			
Minot	W.B.	13,279	57,855.00[i]
Ohio:			
Bellevue	R.A.	11,291	44,070.00[i]
Bucyrus	T.M.	1,650	4,292.00[i]
Cambridge	R.A.	7,500	.....
Chillicothe	T.M.	8,300	18,000.00[c]
Cincinnati	T.M.	7,641	2.50[e]
Washington	T.M.	4,300	2.30
Oklahoma:			
Shawnee	R.A.	50,000	2.15[b]
Oregon:			
Corvallis	W.B.	1,600	.....
Pennsylvania:			
Allentown	A.	4,337	$13,766.00[c]
Butler	T.M.	1,938	1.75
Chambersburg	T.M.	12,500	0.75[e]
Clairton	W.	12,868	1.75[b]
Connellsville	T.	13,152	29,593.00[a]
	W.	1,636	7,218.00[i]
Hazelton	A.	20,826	74,275.00[d]
Lebanon	W.B.	6,200	22,400.00[d]
Norristown	A.	3,600	0.97[e]
	T.M.	22,060	22,876.00[c]
Sayre	T.M.	5,000	1.85
Throop	B.	8,000	4.76[e]
Waynesboro	T.C.	1,200	3.00
	T.M.	3,300	2.00
Rhode Island:			
Cranston	A.M.	30,282.1	1.11[a]
	T.M.	26,025	0.77
Pawtucket	A.M.	19,650	2.50[e]
	T.M.		
Providence	A.M.	24,340	1.88
Woonsocket	A.M.	69,000	1.80
South Carolina:			
Greenville	T.C.	3,700	4,210.00[c]
Tennessee:			
Cleveland	T.M.	6,075	20,250.00[i]
Jackson	W.B.	9,000	1.49[b]
	A.M.	75,000	0.30
Texas:			
Dallas	W.B.	10,576.9	436,815.00[i]
	R.A.	43,214.6	197,540.00[i]
Eastland	A.M.	19,500	2.50[b]
Georgetown	R.A.	20,000	2.05[b]
Mineral Wells	R.A.	5,000[s]	.....
Paris	W.B.	4,332	3.45[c]
Mexia	R.A.	17,600	3.27
San Angelo	A.M.	90,000	1.44
Utah:			
Ogden	W.B.	96,269	342,390.00[r]
Vermont:			
Rutland	A.M.	4,500	0.90[c]
Washington:			
Puyallup	W.B.	7,271	17,713.00[d]
Walla Walla	W.B.	10,100	1.69

BITUMINOUS PAVEMENTS

		Area	Cost
Wisconsin:			
Baraboo	T.M.	1,600	.....
Eau Claire	A.M.	8,727	1.35
Oshkosh	T.M.	11,223	22,296.00[c]
Wyoming:			
Casper	W.B.	23,647	2.11[b]
Sheridan	W.B.	26,719	2.97[b]

A.—Amiesite. A.M.—Asphalt macadam. Asb.—Abesphalt. B.—Bitoslag. N.—National. R.A.—Rock asphalt. T.C.—Tar concrete. T.M.—Tar macadam. W.—Willite. W.B.—Warrenite-Bitulithic. [a]—Surface only. [b]—Surface and base. [c]—Surface, base and grading. [d]—Surface, base, grading and curb. [e]—Surface, base, grading, sewer adjustments. [f]—Surface, base, grading, curb, drainage. [g]—Surface, curb and gutter. [h]—Surface, base, grading, curb and gutter. [i]—Entire improvement. [k]—Entire improvement, including engineering, inspection, etc. [l]—$28,000 on macadam base, $79,000 on concrete base; includes pavement, grading, curb and storm sewers. [m]—$2.68 on 6" concrete base, $1.50 on 6" macadam. [n]—Includes scarifying and rolling old macadam and adding about 2 in. of top. [r]—Resurfacing over old pavement. [s]—Surface, base, grading, catch basins and drains.

Snow Equipment for Boston

The Mayor of Boston, Massachusetts has authorized Joseph A. Rourke, commissioner of Public Works, to investigate the possibility of purchasing from the Federal Government or elsewhere 40 or 50 tractors to be provided with snow plows for the removal of snow next winter; also two mechanical snow loaders for discharging snow into trucks at the side. The Mayor stated that snow removal work this year up to March 1 has cost $450,000 and in addition the presence of snow has caused the destruction of pavement in Massachusetts avenue and Beacon street which it will require $250,000 next spring to repair, most of the damage being done by chains on heavy truck tires travelling in deep ruts in the snow.

Snow Removal in New York

The commissioner of the Department of Street Cleaning of New York, Alfred A Taylor, is receiving credit for unusually effective performance of the snow removal functions of his office during the past winter. The "Woman's Municipal League," in a bulletin dated February 27th, says: "This winter when we read that the snowfall has been exceptionally heavy, we are somewhat surprised because we have never been less incommoded by the snow in our streets. The reason for this is the efficient snow removal." The bulletin then goes on to state that Commissioner Taylor is the first man, for many years at least, to rise to this position through the ranks of the department. Previous commissioners have generally been taken from outside the department, but Mr. Taylor has been connected with it for 23 years, first as a driver, then as section foreman, assistant foreman, borough superintendent, general superintendent, deputy commissioner and finally commissioner. The Woman's League attributes his unusual success in snow-removal to his long training in the department.

The conditions under which he has been keeping the streets passable this winter are indicated by his report made on February 7th to the Board of Estimate and Apportionment in asking for authorization for the issuance of $1,000,000 special revenue bonds for the removal of snow and ice. In this communication he states that up to that date the total fall of snow had been about 36 inches in 11 storms, while the average snowfall for an entire winter is about 24 inches. The snowfall for the winter has therefore been about double the average; in spite of which this civic organization states that the citizens have never been less incommoded by snow. It might also probably be said that never have the papers had less to say about the handling of the snow. Apparently Mr. Taylor has not maintained a publicity bureau, as did some of the previous commissioners.

Since the same men and, to a large extent, the same equipment is used in snow-handling as is in regular use for collection of ashes and garbage, almost every piece of equipment, both horsedrawn and motor, has been in service during the winter. The extent of this equipment was shown in the table in the December issue of Public Works, wherein the department was stated to have on hand 15,000 hand scrapers, 110 bottom-dump wagons, 2 snow-loading machines, 300 push snow plows, 129 5-ton trucks, 12 7½-ton trucks, 100 2-ton trucks and 129 tractors.

Drivers receive $5.45 per day and a request was made by Mr. Taylor that an allowance be made for about 20,000 additional days of driver service to provide for the unusual amount of snowfall. In addition to these, from 1,000 to 4,000 laborers are employed by the day in emergency work after each snowfall.

Cost of Contractors' Bonds

Henry G. Shirley, chairman of the State Highway Commission of Virginia, has been endeavoring to obtain from the bonding companies doing business in that State a reduction of the rates charged contractors on State work, which charges are of course added to the cost of this work to the state.

The chief claim made is that the bonding companies are charging 1½% on the total cost of the contract, whereas under the state specifications the contractor is required to put up a bond of only 30% of the contract price. Mr. Shirley claims that 1½% should be charged against this 30% rather than on the total amount of the contract. The charge made really amounts to 5% on the amount of the bond. The Commission believes that the 30% is sufficient to cover any losses that may be brought about due to the failure of the contractor to comply with the contract and specifications. On February 28 the Commission stated that it expected to bring the matter to the attention of the General Assembly and it is said this may result in the State deciding to eliminate the bonding companies and carry the risks itself.

Garbage Contract for Indianapolis

The City Sanitary Commission of Indianapolis on Feb. 28 awarded a contract for digesters for the new city garbage disposal plant to the William G. Morrison Company. The plant is to be of 200 tons capacity. The award was made

on the recommendation of E. W. McCullough, consulting engineer on the garbage plant construction. The bid for these digesters was $126,800 and Mr. McCullough estimates that the entire plant with the buildings will cost not more than $375,000.

Landslides and Their Prevention

Pittsburgh, Pennsylvania, has had some landslides which, because of the damage they have done, have attracted quite general attention. Similar slides, however, have occurred with less disastrous results in many parts of western Pennsylvania, and, in fact, in various sections of the United States, especially those where clay occurs in synclinal hillsides with rather steep slopes. This phenomenon was discussed before the Engineers' Society of Western Pennsylvania by H. R. Thayer of Pittsburgh. Mr. Thayer's paper is given below:

Western Pennsylvania was formerly a bed of shale and silt lying at the edge of a vast inland sea occupying what is now the basin of the Mississippi. Then some convulsion of nature elevated it, and the drainage systems began to cut out channels. The resulting topography in the vicinity of Pittsburgh has been a series of ridges and valleys. The surface of the shale has disintegrated into clay, and every engineer in the district realizes the problem thereby created. Every cut in these slippery slopes brings with it its risk. They speak about "putting money in a hole," but those who have to contend with a slide do not even get this satisfaction, for the ooze soon fills up every last semblance of any excavation.

I do not know of any better example, however, of the useful application of the truths of science to everyday affairs.

Classification of Earth Movements—We may classify earth movements as of five different types:

The first occurs where the earth is deposited or cut into at a slope exceeding the angle of repose, usually assumed for earth at about 34 degrees. The usual and proper remedy is to flatten the slope or to build a retaining-wall if the former course is impracticable.

The second case is where a heavy load is placed upon the earth. This is really a special case of the first variety and has the same remedies.

The third case is that caused by the disintegration of the material. It gives trouble where too high an angle of repose has been assumed. This is an error likely to occur when excavating in friable rock.

The fourth case, fortunately rare in this district, is caused by earthquakes. There is no remedy; at least, none at present. One has to take what is sent him.

The fifth case, common in this vicinity, is what is called a "slide." In a hillside, apparently solid, an irregular mass breaks loose. The top cracks and heaves in an irregular manner, while a clayey mass pushes out as a toe at the bottom. The motion may be very slow, say a few inches per year to a few inches per day. The force developed is very large and construction to hold it must be correspondingly massive.

So far as the writer knows, slides occur only in a clay soil. Keep clay perfectly dry and it is a most dependable material. Under these circumstances it will remain vertical for a long time if not indefinitely; but water changes its character entirely, rendering it a most treacherous material. Its angle of repose becomes very low, possibly something like 10 degrees. As we should expect, the angle at which the clay will stand depends largely upon the moisture present therein; and if anything happens to increase its moisture content its stability is decreased, and if this goes far enough, movement begins and we have a slide. So far as the writer knows, water is the only cause of slides. If ground which has been stable for a long time starts to move, it will be because the slope has been changed or unusual amounts of water have been introduced.

Methods of Treating Slides.—There are four methods of treating a slide:

The first is to restrain it by means of piles or a retaining wall. Great strength is often needed to make this effective, and these methods are always expensive. The next idea is to "dig it out." This is archaic, expensive, and generally unsatisfactory. There are cases, however, where it is the only thing to be done, although often involving very large amounts of material.

The third method is to drain the affected area, thereby removing the water, which is always the cause of the trouble. This is likely to be expensive, but has proven quite satisfactory.

The last method is one of prevention. It is usually available and will be in every way the most satisfactory. The first step is a careful and thorough investigation. There should be a topographical survey with borings, also a history of the slide with rainfall records and progress chart. The amount of water flowing from the foot of the slide and its variation and nature should be carefully observed. The water may be from springs, from the surface, sewage, or water-supply. From the above data it should be easy to determine the source.

The next step—locating the definite place from which the trouble comes—will not give engineers very much trouble as these methods are too well known to need elaboration here. If it be a leaky waterpipe it is resoldered or, better still, moved to a more favorable location. Sewer-pipe we may likewise mend or move, while surface drainage may be ditched off the slope. The treatment of spring water will give the most trouble, but, since this has always been present, the chances are that it is not the cause, unless someone has been careless enough to fill directly over a spring.

To prevent a slide:

If possible, avoid digging into a clay slope carrying water in greater or less quantities. If

it must be done, drain thoroughly and keep out all the water you can. Locate water and sewer-pipes as far away as you can. Turf the slopes.

If water can be excluded, and you can be sure that external water will always be kept out, a slope of 34 degrees (1½ to 1) can be used with confidence.

Public Engineering on Part Time

The following letter from the township engineer of Cranford, N. J., was probably suggested chiefly by the article on page 56 of our February issue, telling of an investigation of the subject being made by the American Association of Engineers:

Editor, Public Works,
New York City.

Dear Sir:

Regarding engineering of public work on part time, your articles are interesting as a subject of importance to engineers and also to community interests. I believe the underlying difficulty in devoting engineering practice exclusively to public work is the uncertainty as regards permanence of effort and the desire on the part of the public to engage efficient talent with insufficient remuneration. The public is the ruler of its own destiny and is apt to measure economy in terms of competition without regard to the fact that competition for municipal progress is a vague element ranging somewhere between prosperity and stagnation. In such a case of competition the low bidder is apt to be kept busy making both ends meet, and is driven to the necessity of seeking additional revenue from outside sources. Even when a community has managed to secure a competent engineer with sufficient salary to liberate his attention to public interests he is apt to be made the target for political attack which has the same effect in demanding a financial anchor to windward in self-defense.

We see evidences all around us of engineers of attainment who have been thrown into the discard without intelligent reason. Men who have been in harness on the particular work in question, who have had to correct mistakes, who have perfected an organization and established policies for the future, who have the imagination and vision to record future ideals and the courage to follow them, who understand the outside influences which must necessarily modify public engineering ambition and men who have been specially trained to understand the interwoven fabric of the particular work, thrown out without justification and the responsibilities turned over to one who, whatever his qualifications may be, cannot hope to grasp every phase of the situation for a long time and may then inadvertently undo much valuable work.

As long as the engineer holds his term of office between election days, so long will any competent engineer decline to undertake responsibilities which require years of effort unless he has other profitable channels for keeping alive. Until there is some substantial evidence of sincerity in consistent progress, his loyal interest can hardly be expected. If his work cannot be supported by confidence both ways, his efforts are futile. If he is underpaid his interest in the work is in the same proportion, or less.

It is not a reflection on public officials to say that most of the smaller municipalities suffer from the fact that their entire present and future is given over to officials who have to direct it during spare moments, with the result that progress is often propelled by explosive impulse rather than calm understanding or by authority instead of judgment. Various departments may operate efficiently and each perform its own function but with the obvious lack of coordinated vision which limits progress to routine necessities. Succeeding administrations come and go and rarely with full appreciation of the technical needs and functions which really hold things together. An official can hardly be expected to assume responsibilities beyond his probable term of office.

The result of this part-time service is that there is no one persistently studying the future and recommending steps to anticipate the growing needs. Bills for improvements are collected and things drift along until some appalling disaster shows that they are way behind the times and a hysterical impulse tears things up that might have been made to anticipate such inevitable conditions had there been some one on the job to look ahead.

These are the wastes of magnitude, compared to which a real salary for a permament, full-time engineer is the biggest kind of insurance. I believe progress can be made without destruction or disaster and that it will cost much less to keep ahead of the times than it will to be everlastingly trying to keep up.

Every step forward in building up a community is an essential part of the inheritance we are building for future generations. If we study the history of such developments we find a blazing trail of shortsighted blunders which, if repeated at present-day values, will become disastrously extravagant. We find expensive improvements have to be destroyed to make room for unexpected needs. We find that indifference to the future or lack of vision or initiative has passed golden opportunities to provide for the future and vital matters have later forced themselves upon them at ruinous costs. The people come and go but the fundamental process of development should go on in an unbroken plan of advancement based upon an intimate familiarity with all elements which combine to our economic growth.

The responsibility of the public is an elusive quantity, that of the elected officials is apt to be limited to the spare moments they can devote to the generalship of public work, the engineers' responsibilities embrace only such accomplishments as are made during an indefinite term of office, probably on part time, and the limited powers conferred upon him by the governing body. To whom then can the blame be assigned for past shortsighted mistakes? History repeats itself but it is now a period when repetition spells serious expenditures.

There are many problems in public work which must be controlled by the judgment of the public through their elected representatives. Financial developments must be directed by the prevailing conditions and the raising of funds follows the desire of the public who pay the bills. Improvements and new construction must follow the developments as they occur. Legal procedure will change as time goes on. New problems will come up for analysis at any time, but the existing physical properties of a community are a living reality representing the investments of a generation which must be protected against abuse, deterioration and manipulation at any hazard. An intimate knowledge of their construction, their limitations, their ills and their suitability to future extension is a most essential factor to good judgment in emergency and cannot be comprehended under a sporadic supervision nor on part-time service.

The maintenance and development of public property presents many complications mostly of an engineering character and all worthy of an engineering supervision. When the public appreciate the true value of a permanent engineering management they may feel sure of competent upkeep and consistent progress. When they realize that the comparative expense of a full-time engineering supervision lies not so much in the amount paid as in the economies secured by the prudence of management, then I feel sure competent engineers will enthusiastically welcome the lure of public achievement, at full time and for life, even at a sacrifice of financial ambition; but it must be for a term of office that renders their success possible and will insure an uninterrupted exchange of confidence and cooperation without political interference.

D. C. NEWMAN COLLINS, M.Am., Soc. C.E.

A Record Year for Asphalt

It is stated by the Asphalt Division of the Standard Oil Company that 1922 was a record-breaking year for asphalt paving on the Pacific coast. During that year contracts were awarded in the five Pacific coast states for constructing 49,250,000 square feet of asphaltic concrete base and surface pavements. In 1921 the total was a little over 40,000,000, and in 1920 a little over 28,000,000 square feet for this type of pavement.

The gains in asphaltic concrete surfacing on various types of bases and in asphalt and oil macadam pavements are even greater. The total area of pavements laid in 1922 in which asphalt was used amounts to 108,000,019 square feet, equivalent to 1290 miles of a 16-foot highway.

Road Construction in Illinois

The Division of Highways of Illinois has published a statement giving the amount of roadwork completed during the years 1921 and 1922, the latter of which was a record year for the State. At the peak of construction as much as 41 miles of 18-foot Portland cement concrete pavement was being constructed each week and it is believed that this rate would have been maintained if not increased but for the rail strike, coal strike and cement and coal shortages. In spite of this, 722 miles of pavement was constructed during the year, which is claimed as the world's record in mileage of pavement completed in any one year by any one State. Another record is claimed for length constructed in one day, one of the contractors having laid 1,583 feet of 18-foot concrete pavement in one day of ten hours.

The total work done during the two years comprised 1,137 miles of pavement, 343 miles of grading and 272 bridges. In addition to this, the State had under contract but not completed on January 1st, 676 miles of pavement of the bond issue system and 114 miles of State aid pavement; 103 miles of grading under the former and 5 miles of grading under the latter, and 103 bond issue bridges and 16 State aid bridges.

The Beccari Garbage Disposal Process

An entirely new idea in garbage disposal which has been tried out in Italy is being introduced in this country by the American Beccari Corporation, with which are associated J. Waldo Smith as president, Jules Breuchaud as vice-president, James F. Sanborn as secretary, and other engineers and contractors.

The process is the invention of Dr. Guiseppe Beccari and is claimed to change garbage unmixed with other refuse matters into a practicable fertilizer. There is practically no cost of operation, but the garbage is deposited in covered masonry cells from 8 to 10 feet in each of the three dimensions. Each cell has a charging hole on top and a door in one face through which the finished product is removed; also a low tower on the roof.

The garbage is dumped through the charging hole and the liquids are drained off through the bottom, which is provided with fine holes or slots, from which it is conducted to the sewer or other conduit for removal. Air also enters through the same perforations in the bottom. Four shelves projecting about 2 inches from the wall extend in a continuous line along the four sides of each cell and about 2 feet apart vertically. Each tower contains four shelves around its circular perimeter on which are placed absorbent earth and sulphated iron, which are supposed to fix the volatile products (nitrogen and ammonia) carried upward in the air rising from the cell, which air has entered through the perforated bottom and also up vertical air ducts which are placed in each corner and are connected with the unfilled space created underneath each horizontal shelf, the purpose of these shelves being to distribute the air through the cell. The cells are ordinarily built in units of four with one tower at their common corner and serving all four cells.

When the garbage has fermented in a cell for from forty to forty-five days, the temperature meantime having risen to about 150° F., it is found that chemical and bacterial action have reduced the garbage to a dry, inoffensive mass having the nature of humus. This is removed through the doors and when a cell has been emptied it is ready for a new charge. Each cell receives about 24 cubic yards at a charge and it is estimated would therefore serve about 1,000 population of a residential community.

It is claimed that such a plant creates no dust, smoke, gases or other nuisance and can thus be placed at any point in the city where land is available and hauling can therefore be kept at a minimum, that the operation costs are very low and the deterioration as well, and that it produces a fertilizer which finds a ready market.

Value of Cost Accounting

Cost accounting has become established as necessary for a contractor who is to profit at the business and should be introduced by and required of all public works departments, especially in cases where such works are performed by the department directly by day labor. Some cost accounting systems, however, are so complicated or unwisely planned that they do not secure a maximum of benefit and may even cost more than they are worth.

The Fabricated Production Department of the Chamber of Commerce of United States has issued twelve rules for testing the value of a cost accounting system. Although prepared for a manufacturing business, most of the rules apply to contract work also. These rules, which it recommends applying for analyzing the soundness of a cost system, are as follows:

Does your cost system give you up-to-date costs, not merely history?

Does it aid in stabilizing your wages and piecework rates?

Does it point out defects in your routing system?

Does it help you maintain a perpetual inventory?

Does it increase your production?

Does it measure your overhead?

Does it detect new overhead expense?

Does it point out leaks in expense?

Does it encourage your employees?

Does it promote intelligent competition?

Does it point to non-profit paying lines?

Does it permit you to bid safely?

Recent Legal Decisions

CONTRACT OF EMPLOYMENT OF ARCHITECT FOR PUBLIC WORK MUST BE MADE BY PROPER AUTHORITY

A city passed a resolution that an architect be selected to prepare a preliminary statement and estimate of probable cost of improvements to the city market, for a sum of $100, and should the council determine to proceed with the work at any time, such architect should be employed to prepare the plans and specifications and superintend the work at the standard charges. An architect was selected and prepared the preliminary statement and estimate, for which he was paid $100. Bids for the work were advertised for under a resolution of the city, but none was accepted and the work was never proceeded with. The architect subsequently sued the city for preparing plans and specifications under directions orally given him by the chairman of the market committee. The Georgia Court of Appeals, Mayor, etc., of Savannah, v. Kops, 113 S. E. 99, holds that it was error to overrule a demurrer to the petition, because it was not alleged that upon the authority of the mayor and aldermen the market committee contracted with the plaintiff for any additional plans or estimates other than the estimate for which he was paid. It was not alleged that he prepared any specifications other than those for which he was paid, prior to the resolution which directed an advertisement for bids. It was not shown by the petition that any proper resolution "to proceed with the work" was ever passed by the city. Under the court's view of the resolution authorizing the employment of an architect, it would have been necessary for the city to express by proper resolution its intention to proceed with the work, and for a contract to be duly entered into by the proper authority with the plaintiff, in accordance with the resolution.

OPTION TO TAKE OVER WORK — ALTERATIONS CONTEMPLATED BY CONTRACT DO NOT RELEASE SURETY

The West Virginia Supreme Court of Appeals holds, State v. R. M. Hudson Paving & Construction Co. et al., 113 S. E. 251, that where a county court enters into a contract with a contractor for the permanent improvement of a public road, which provides that, in case the contractor shall make default in the due performance of the contract, the county court, in case such default shall continue for a specific period after notice, shall have full power and authority to take the work, in whole or in part, out of the contractor's hands or otherwise, it is not bound to do so, but may sue the contractor and its surety upon its bond without taking over the work. If the contract permits alterations in work or materials at the option of the county court, the surety will not be discharged by material alterations in work or materials without its express consent, where such alterations are contemplated by the terms of the contract.

A county court entered into a "blanket form" contract for all the work and materials in the construction of a public road. Six different kinds of paving materials were designated, upon which the contractor made alternate bids upon a unit basis. The paving material finally agreed upon was rocmac, but by the terms of the contract the county court reserved the right to make any changes in the work or materials it might deem proper. The contractor executed the usual bond. The county court afterwards substituted concrete of a 1-2-4 mixture for the rocmac paving, the contractor agreeing to furnish and lay it for the same price per square yard. Such a change, though made without the knowledge of the surety, was held not to release it from its liability. The damages were assessed as of the date of the breach of the contractor's contract.

CITY BOARD OF COMMISSIONERS CANNOT DELEGATE DISCRETIONARY POWER TO MAKE CONTRACTS TO ONE COMMISSIONER

The Kentucky Court of Appeals holds, Jamieson v. City of Paducah, 241 S. W. 327, that a city council, board of commissioners, or fiscal court cannot delegate to another, not even to its individual members, the performance of official duties involving the exercise of discretion, and if it attempts to do so the action or contract of the agent is not binding on the official body. An attempt by a board of commissioners of a city to delegate to commissioner the power and authority to act for and on behalf of the city in making a contract for plans and specifications for a public building, without limit as to price, was held to be an attempt to confer upon him the exercise of a discretionary power. Had the board ratified the contract and entered a proper order, the city would have been bound, but this had not been done. The most the ordinance conferred on the commissioner was authority on behalf of the city to consult with the architect concerning plans and specifications and to submit any proposition which he might receive from the architect to the board for consideration and approval. It is also held that persons dealing with a municipal corporation are bound, at their peril, to know that the contracts made by the officials of such corporation are executed in the mode pointed out by its charter and ordinances, and if such persons fail to inform themselves as to whether the official has power to contract, they must suffer the consequences. "A city council or board of commissioners of a municipality can speak only through its records. The city can contract in no other way. It cannot be made liable on an implied contract, except where it has received goods, property or benefits, and applied the same to its own use, and the said property or benefits can be restored to the person from whom the municipality obtained the same without destroying the city property to which it is attached, and then its liability goes only to the extent of the reasonable value of such material in the place where found, after the city elects to keep it."

PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 54 April, 1923 No. 4

Unusual Features of a Florida Concrete Road

A contractor from Iowa lays 43 miles of concrete road in Florida, using stone from South Carolina, sand from 200 miles away and cement from 400 miles. Plant used in averaging more than a thousand feet a day.

By M. C. Winterburn*

It is one thing to build a concrete road in "your own back yard," but the building of forty-three miles in a section far removed from material sources and where practically all conditions are new, and furthermore to complete the same in one year's time, is quite another.

This is what C. F. Lytle, of Sioux City, Iowa, has been doing the past year. Early in 1922 Mr. Lytle contracted with the Florida State Road Department to build Federal Aid Projects Nos. 11, 21, 22 and 23, consisting of 43 miles of concrete road between Jacksonville and Lake City, Florida—one of the longest continuous pieces of road ever paved under one contract. This contract extends from the end of a brick road, seven miles west of Jacksonville, to a point about ten miles east of Lake City, the road being known as State Road No. 1.

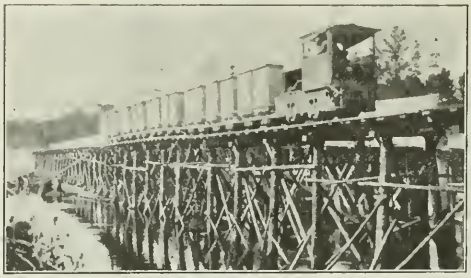
The highway parallels the Seaboard Railroad the entire distance, lying north of it for 30 miles and then crossing to the south side. The highway also crosses the A. C. L. R. R. At 23 miles from the east end it crosses Little St. Mary's River, where a trestle was used for industrial track.

An humble start at pouring concrete was made on May 15, 1922, about 40 miles had been completed early in April and it is believed that the entire work will be completed by May 12. Every road contractor will appreciate the amount of effort expended in assembling the necessary equipment and organizing the man power for a job of this magnitude and keeping up an average of nearly a thousand feet a day for fifty consecutive weeks.

On March 22 the entire road had been completed for a little over 35 miles, and it was expected that by April 20th about 4¾ miles more would be completed, an average of a thousand feet for every day elapsed except Sundays.

*Superintendent for C. F. Lytle.

A SECTION OF FINISHED ROAD, SHOWING CULVERT. RAILROAD IN BACKGROUND.



TEMPORARY TRESTLE OVER LITTLE ST. MARY'S RIVER.

This trestle was over 800 feet long and was built to carry the industrial track for transporting the concrete aggregate from the central bins to the mixer. A train of batch boxes is seen crossing.

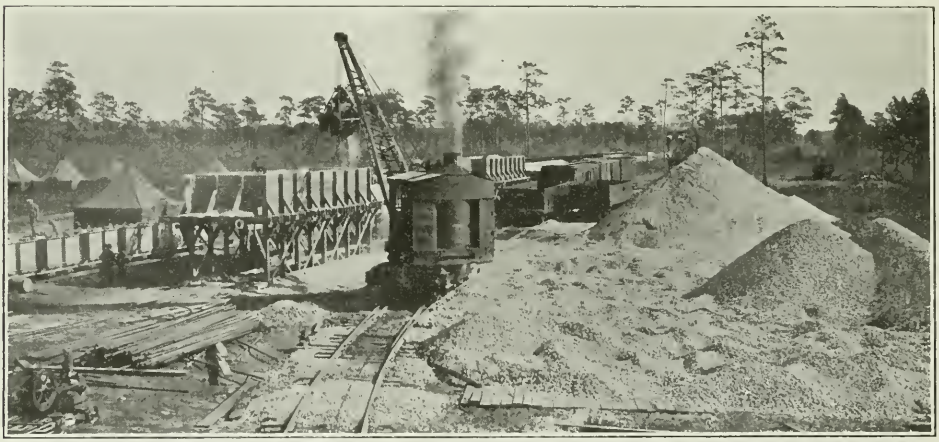
The pavement is sixteen feet in width and the thickness is 6-7½-6 inches, with expansion joints placed every forty-five feet.

PREPARING SUBGRADE

Most of the soil is very sandy and a very hard and uniform sub-grade is made by the "flooding" method. This method was carried on as follows. After the forms have been set and the road brought to approximate grade, it is flooded with water. After this has dried sufficiently, it is rolled and a final cut made with a Lakewood sub-grader, bringing the roadway to finish grade. It is again flooded and when the water has soaked away the sub-grade is left very hard and in excellent shape for paving. To avoid absorption of water from the concrete, the sub-grade is generously wet down just ahead of the mixer.

HANDLING MATERIALS

One of the most interesting features of this project was the material supply. Crushed rock, of which eighteen hundred cars are required, is shipped from Columbia, South Carolina, an average distance to the proportioning plants of over three hundred miles. Nine hundred cars of sand will have been transported an average of two hundred miles and nearly six hundred cars of cement will have been shipped from points over four hundred miles from the work. In all, a rail haul of 45,000,000 ton-miles will be required to supply the necessary materials for the job or, figuring the length of the average car to be forty feet, a freight train twenty-five miles long is required in hauling the material for this forty-three miles of road.



VIEW OF PLANT AT McCLENNEY, NEAR LITTLE ST. MARY'S RIVER.

Crane is seen filling bins with rock and sand. Track running under bins carries industrial cars, each with two batch boxes, which are filled from the bins by gravity. Eight batches are loaded at one spot. Workmen's tents are seen at the left.

The material was handled from five propor-

MAKING SUBGRADE.

The roller is compacting the sand between the side forms, which are shown. At the right is the industrial track. Behind the roller the subgrade is being surfaced by means of a subgrader. The top of the concrete mixer is seen in the far background. This stretch was almost impassable before being paved.

tioning plants, the first being located 4.25 miles from the east end of the project and others at intervals of 8.5 miles from this point to the west. Thus about 8.5 miles or approximately 80,000 yards were paved from each plant with an average industrial haul of 2.15 miles.

THE PLANT USED

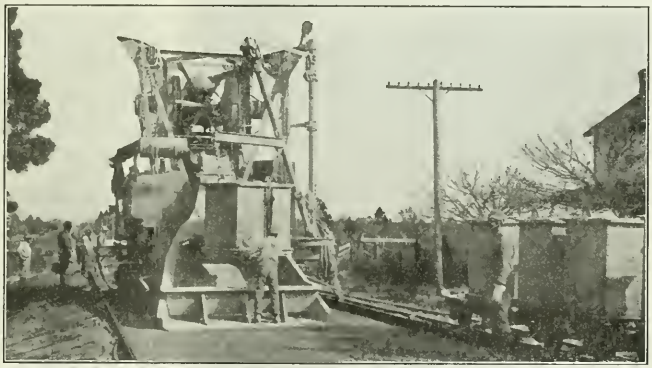
Each plant consisted of standard gage track to accommodate 14 cars of crushed rock and sand and 5 cars of cement at each spot. The rock and sand hoppers were designed to hold 150 tons each. Cement was handled direct from cars to batch boxes, no attempt being made to store any particular quantity of this material. Rough material was handled from the cars and to the hoppers with two Orton & Steinbrenner locomotive cranes, one working at the proportioning plant in operation and the other "stocking up" at the location of the next set up.

One hundred and fifty Koppel batch boxes each of 48 cu. ft. capacity, with 85 Koppel cars and five miles of Koppel 24-inch gage track, together with five Whitcomb gasoline locomotives (one of which was used as a switch engine) comprised the transportation equipment.

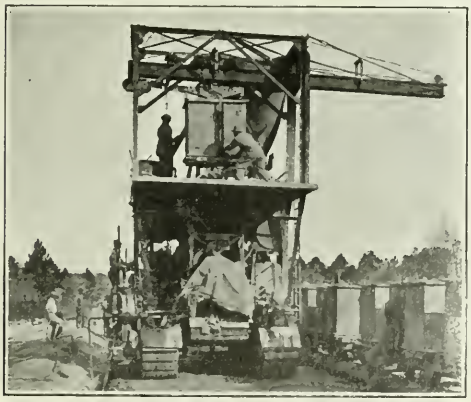
One Koehring 32 and one Austin 28 mixed the concrete, which was finished with Lakewood

WORKMEN'S LIVING QUARTERS.
Above: Mess hall and white men's quarters. Below: Quarters for colored labor.

machines, four of these being kept on hand. Two Austin 10-ton gas road rollers and two Lakewood sub-graders were used in preparing sub-grade. Ten thousand feet of Heltzel steel forms were employed. Four Domestic pumps furnished water through eight miles of 2-inch pipe from fifteen batteries of 2-inch wells ranging in depth from 130 to 220 feet.



CONCRETE MIXERS.
At the right is seen the Koehring mixer in action, and below the Austin. The batch boxes are swung over to the skip by the attached crane of the former; the latter lifts the boxes by means of jib and traveling hoist. In each case a complete batch is discharged into the mixer from one box.



Twenty 16 x 16 squad tents with wooden floors and sides, well screened, provided quarters for the men. A mess hall feeding 120 at one time, whites at one end, colored labor at the other with kitchen between, came in for particular attention three times per day. A well equipped repair shop was installed in charge of expert mechanics to take care of all mechanical repairs. The entire plant and camp was efficiently lighted by the use of a portable Fairbanks-Morse lighting plant. Two smaller plants were used in making night repairs on the road.

Moving from one setup to another, which involved a "leap-frog" performance, was not the least important detail. This meant the transferring of all plant equipment except the standard gage track, all camp equipment,

COVERING FRESHLY LAID CONCRETE

Elevated canvas covers are placed over the new concrete. Later the canvas is allowed to rest on the concrete. After the first day the concrete is kept covered with damp earth. A train carrying 24 batch boxes is seen in the background.

one mixing and sub-grading outfit as well as taking up, moving and relaying five miles of industrial track and about the same

CLEANING AND BUNDLING CEMENT BAGS

About three thousand sacks are cleaned and bundled per day, at considerable profit to the contractor. In the background is seen a canvas-covered train shed.

amount of water pipe. This work was prosecuted day and night with the result that the

THE RESPONSIBLE PARTIES

From left to right: C. A. Root, resident engineer; E. E. Albee, Federal Government inspector; M. C. Winterburn, superintendent; John R. Slade, testing engineer.

move from plant No. 4 to plant No. 5 was accomplished in 50 hours and caused the loss of only two days of mixing time.

At no time during the progress of the job has any attempt been made to make a record run, but every effort is made to get the most out of every day. As a result of this continuous effort, 8.75 miles or nearly 83,000 square yards of pavement was laid and a move made between January 30th and March 24th, an elapsed time of 54 days which included 7 Sundays and 3½ days lost on account of rain; giving an average per working day of 1,062 lineal feet, or 1,888 sq. yds.; or 855½ feet per day of elapsed time. The average for the entire year, including Sundays, holidays and all, from the date of the first pouring, is about 630 feet.

South Carolina Highways

The State Highway system of South Carolina, on January 1, 1923, contained 3,519 miles, of which 3,225 miles had been proposed for Federal aid. Based on 7% of the public road mileage of the State, 3,662 miles is eligible for federal aid.

During 1922, 73 miles of hard surface roads were constructed, giving a total of 158.8 miles of hard surface constructed to date, while 41 miles were under contract. During the year 475 miles of types other than hard surface were constructed and 225 miles under contract. Altogether 2,307 miles of the state system were either improved or under contract by the first of this year. The State Highway Commission reported that 300 additional miles of hard surface were needed to care for the present traffic and that 913 additional miles of other types were needed.

During the year surveys made for which the records are complete totalled 215.85 miles, the cost of this work being $16,047, an average cost of $74.34 per mile. Plans were prepared for 440 miles at an average cost of $48.10 per mile.

Seventy-four contracts were let during the year, the greatest number in any one month being 14 in May, 16 having been let prior to that month. The unit costs of the successful bids during the entire year averaged as follows: Clearing and grubbing $91.77 per acre, common excavation 26c per cubic yard, rock excavation dry $1.67 per cubic yard, rock excavation wet $4.66 per cubic yard, top soil surfacing 27c per cubic yard, sand-clay surfacing 24.7c per cubic yard, clay-gravel surfacing 23c per cubic yard, clay bound macadam 46.5c per square yard, shaping subgrade $2.00 per thousand lineal feet, gravel surfacing $1.37 per cubic yard, bituminous concrete surfacing 94.7c per square yard, plain concrete surfacing $2.48 per square yard, reinforced concrete surfacing $2.87 per square yard, concrete base $1.51 per square yard, sheet asphalt surface 98.5c per square yard, rock asphalt pavement $2.06 per square yard, shell surfacing 78c per square yard. Class A concrete $20.83 per cubic yard, Class B concrete $18.22 per cubic yard, Class C concrete $20.25 per cubic yard.

The cost of pipe culverts was materially reduced by requiring all pipe for state department work to be purchased from one producer. This resulted in

somewhat better prices and, on account of inspection of manufacture at the plant, a better quality of pipe.

At the beginning of 1922 the state had under maintenance 1,319 miles and at the end of the year 1,910 miles, an average of 1,603 miles during the year. The total cost of state maintenance was $382,361, an average of $240.68 per mile. The Commission states: "In considering the cost per mile for maintenance, it should be remembered that the funds available for maintenance in some of the counties have been altogether insufficient and in those cases the roads have suffered in consequence."

The principal additions to the completed mileage were in the Calhoun Highway which extends across the state, and about 20 miles to the old "Ninety-six Road."

The cost of surveys in 1921 averaged $59.14 per mile, the increase in 1922 being due largely to the increased proportion of work in the mountainous portions of the state. For the same reason the cost of preparing road plans increased from $40.54 in 1921 to $48.10 in 1922. Surveys and plans for bridges averaged 97c. per foot of bridge planned or 1.75% of the total estimated cost.

Wet Excavation by Dragline Cableway

The hydraulic canal and forebay of the Cohoes, New York, Power and Light Corporation has been enlarged as part of the project for increasing the capacity of the hydro-electric plant and providing power for various industries which formerly used the canal for their individual power plants. It was necessary that this work be performed without interfering with the operation of the hydro-electric plant and that the equipment handle wet material which ranged from a sticky mixture of clay and loam to shale rock which could be removed with very little blasting.

The contract for this work was let to Sanderson & Porter. For the excavating they used a 400-foot span 1-cubic-yard Sauerman dragline cableway excavator. Excavation was begun in May, 1922, and in this month 7,200 cubic yards of earth under water were excavated. During June, 4,650 cubic yards of earth and 2,630 cubic yards of rock were removed. During part of both months the cableway operated 18 hours a day in two shifts. Very little drilling or blasting was necessary as the excavator was sufficiently powerful to bring up most of the shale without blasting. The best day's record was 547½ cubic yards, but the contractors state that 60 cubic yards could be handled in one hour when conditions were just right. The field engineer in charge of the work for the contractor, D. S. Pelletier, estimated that the earth excavation cost 51c. per cubic yard and the rock excavation $1.03.

The excavated material was delivered to a hopper between the canal and the river, the latter of which was nearly 100 feet below the former, and from the hopper the material was sluiced down to the riverbank and used for a fill around the power house. In order to sluice the material, water was pumped into the hopper from the canal by a 6-inch electric centrifugal pump.

The average distance the material was moved by the dragline was 275 feet. The average depth of cut was 6½ feet in an average depth of 15 feet of water.

Broken Stone Bases and Brick Pavements

Discussion of the tests made on the Bates Experimental Highway and some conclusions and lessons drawn therefrom.

By Charles Carroll Brown *

Several designs were used for the brick pavements included among the sections of the Bates Experimental Highway, ranging from a 3-inch brick with 2-inch sand cushion on a 4-inch macadam base, to a 3-inch brick with 1-inch sand cushion on a 6½-inch Portland cement concrete base. Some sections were constructed with bituminous filler and some with Portland cement grout filler. In some sections the bricks were lugless, and in some they had lugs. Almost any combination within these limits may be found in the 28 sections and sub-sections.

BASE

As to base, failures are recorded as occurring when the breaks under traffic have produced separation of small enough areas to cause depression under subsequent applications of loads, so that the impact on the area and on the adjacent edges of the pavement is unduly increased, causing progressive failure of the pavement to extend rapidly out from the break. This follows the practice regarding breaks in the surface of rigid pavements.

The cement-filled brick pavements, especially the monolithic and semi-monolithic types, are considered to be rigid pavements and the bituminous filled brick pavements as flexible surfaces. This is not strictly correct in all cases, however, as there are instances of separation of the brick layer from the base, particularly in semi-monolithic pavements, which occurred even before the test began, and others which occurred after the shocks of the traffic began, and in such cases the bricks soon separated from each other, reducing the rigidity to that of the base alone.

Macadam Bases Under Brick. The sections of brick pavement and one of asphaltic concrete on macadam base were located near a culvert under the road where, on account of the lack of drainage of the road, the water gathered, and as a

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consequence these sections were for much of the time soaked with water. The advantage of the lower layers of the macadam in preventing the capillary action of the water (constantly in the clay of the sub-base) from reaching the wearing surface was therefore lost, and as a consequence the tests gave no information regarding the value of a macadam base under ordinary and reasonable conditions.

Under these conditions, which were much worse than those existing in practically all the remainder of the highway, the results were as follows:

For the first test, each front wheel carried 1,250 lbs. (250 lbs. per in. width of tire), and each rear wheel carried 2,500 lbs. (450 lbs. per inch width of tire). The trucks made 1,000 trips in the aggregate, of which 500 were made up and down the center, except when passing each other, and 500 were made up one side and down the other, with wheels 18 inches from edge of pavement.

There were no failures of brick pavement on macadam base. There was practically complete failure along the wheel tracks of Section 10, 2-inch asphaltic concrete (Topeka mix), on 4-inch Novaculite base, and there were three failures in a section of 2-inch Topeka mix on 4-inch macadam base. There were three breaks on a 3-inch brick pavement with 1-inch sand cushion on 6½-inch concrete base; from one to three small breaks on each of five sections of 3 or 4-inch brick on 2 and 3-inch concrete base, monolithic and semi-monolithic construction. There were two breaks each on a section of 4-inch Portland cement concrete on 4-inch broken stone base.

For this small amount of light truck traffic the macadam base shows up well, notwithstanding its handicap as to drainage conditions.

For the second test, 3-ton trucks were used, and the load was increased to 2,150 lbs. on each front wheel (430 lbs. per inch width), and 3,500 lbs. on each rear wheel (350 lbs. per inch width). For 627 trips of trucks, the wheels traveled on the edges of the pavement, but thereafter for the full period of the test the trucks ran west with the outside rear wheels 2½ ft. from the north edge and came back along the south edge. Warmer weather in May expanded the pavement so that the free corners of slabs were more or less completely held in place by the binding action of the tightly crowded adjacent slab. To reduce the slabs to normal conditions of cooler weather, a 1-inch cut was made through each section of rigid type, the joint thus formed being filled with asphalt. After this the last 1,000 trips of trucks in this second set were made.

The curling up of the edges of the pavement at night having been discovered, 1,033 of the 3,200 trips of this set were made at night.

The loads used produced strains in 4-inch bases or rigid pavement which were so near the ultimate strength of slabs of this thickness that they might be expected to fail under 3,200 applications. The same would be true of the rigid or semi-rigid wearing surfaces on macadam bases. Such bases might themselves be expected to give way on so poor a foundation as they had, emphasized as this was by the extra amount of water almost always present on the sections of the highway in which most of them were located.

In fact, the sections of 3-inch and 4-inch lug and lugless brick on 4-inch broken stone base with 2-inch sand cushion, with bituminous filler, were considered to have failed after 1,000 trips of the second set or 2,000 trips in all, the failures taking place along wheel tracks. The sections of 4-inch and 3-inch lugless brick with 1-inch and 2-inch mastic cushion, 8-inch broken stone base and bituminous filler, lasted but little longer, failing rapidly after 1,500 trips of the second set, or 2,500 trips in all.

Macadam Under Asphalt. The best comparison of strength of macadam base is found in the action of the various thicknesses under asphaltic concrete wearing surface.

With 2-inch Topeka mix and 4-inch broken stone base, there was practically continuous and complete failure after the second set of 3,200 trips of 3,500-lb. load, following the 1,000 trips of 2,500-lb. load in the first set. With 4-inch Novaculite base the failure was complete under the first set—1,000 trips with 2,500-lb. load.

With 6-inch macadam base there were six points of incipient failure under the second set of trips; two additional points of incipient failure under the third set of 3,000 trips of 4,500-lb. load; practically complete failure under the fourth set of trips with 3,000 trips of 5,500-lb. loads. The fifth set of trips, 3,000 with 6,500-lb. loads and 3,000 trips of the sixth set with 19,860-lb. loads (8,000 lbs. on each rear wheel), were run over this section. Observation by the writer on October 13 showed the section to be in fairly usable condition for light traffic, with one break and some depressions along the south side where the truck wheels ran along the edge of the pavement.

With 8-inch macadam base there were six failures of apparently decisive character under the second set of trips; eight points of decisive failure, nine points of incipient failure and five points of progressive failure, this loading being considered in excess of the capacity of the pavement. The fourth and fifth sets of trips and 3,000 trips of the sixth set were run over the section, with similar notations regarding effects of loads. Observation by the writer showed poor condition with many breaks and with considerable depressions along the south side.

With 10-inch macadam base there were three failures under the second set of loads; three additional failures and two points of progressive failure under the third set of loads, which is considered the limit of strength of this type. Similar notation is made regarding loads and additional failures under fourth, fifth and part of sixth sets of trips, and the writer's observation showed the portion of the section most nearly out of water to be in fair condition for light traffic.

That the relative value of these macadam bases under the same Topeka mix top is not in proportion to their thickness, but is more nearly according to their distance from the bottom of the

slope where the soaking with water was most continuous, is very strongly indicated by the official reports and by the writer's observations, which were made without noticing the relative depth of macadam base.

That the forcing of the macadam into the sub-grade, softened by water, was the cause of the rutting of the brick pavements on macadam base was also evident, without reference to thickness of base. The sections with 8-inch macadam base were farther down the slope toward the culvert than those with 4-inch base. In other words, the test was a failure so far as ability to make reasonable comparison between macadam bases of different thickness and material is concerned or between macadam and other bases, mainly because they were located in the worst conditions on a road which is in general located where the conditions can hardly be equalled for badness except possibly in Illinois.

To make the record complete it may be said that Section 8 varies from those above described by having 1½-inch Topeka surface with 1½-inch binder course on 5-inch macadam base. It had no apparent failures under the first and second sets of trips; two points of incipient failure under the third; two additional points and one point of progressive failure under the fourth. It stood up so well that after 1,000 applications of the load of the fifth set of trips, water was poured into three short trenches along the south edge of the pavement and these trenches were then filled with tamped Novaculite. During the passage of the other 2,000 loads of the set there were failures at each of these points, and the conclusion is drawn that the sub-grade under this section would have failed earlier if the previous sets of trips had occurred during the spring conditions when the sub-grade is highly saturated. It does not seem to have occurred to any one that the better quality of this section might be due to better design of the pavement rather than to better conditions of moisture in the sub-grade. The writer's note regarding the appearance of this section during his visit in October reads: "Fair condition except one break and some depressions along the south side. Section 6 was partly in the water near the culvert and Sections 7, 8, 9, were in order going up the slight slope, with little if any difference in sub-grade, so far as surface indications were concerned."

Another section may throw more light on this subject. Section 58 is of 4 inches of 1-2-3½ concrete on 4-inch rolled stone base course. This section had two corner failures under the first set of trips; another corner failure, indecisive, under the second set; another adjacent to previously broken corner, also indecisive, under the third set. Thus far this section was doing so much better than other concrete pavements of 4-inch, 5-inch and even greater thickness, that similar supposition of drying out of sub-grade was apparently made; at any rate, after 1,750 applications of the fourth load, 2,000 gallons of water were run into the rolled stone base. Two additional corner failures, one with progressive breaking, occurred during this set of trips after this was done. Other breaks occurred under the fifth set of trips and it was noted that the limit of this pavement was reached under the fourth set. Traffic was continued through the fifth set of trips and the 5,000 day trips of the sixth set with maximum loads, but was discontinued then so that the last 5,000 night trips did not pass over it. The writer's notes show that this section is most of it in good condition except a number of cracks and two depressions along the south side and breaks at joints. It was in much better condition than Section 57, and Sections 59, 60, 61A, 61B, were destroyed. Again it does not seem to have occurred to any one that the pavement was in better condition because it was better designed.

BASE DESIGNS SUGGESTED BY TEST

The writer has been studying durability of pavements laid on sand base with and without proper drainage and with or without waterproof surfaces and working out designs for improvements in them. He is therefore in the proper state of mind to take the results of the tests of the above named sections of the Bates Highway and apply them in his design.

In the first place, it is desirable to carry away the water from a pavement as rapidly and completely as possible.

In the second place, if this cannot be done and the sub-grade has strong capillarity, it is necessary to stop the passage of this water up to and through the pavement.

Third, it is necessary to make the surface waterproof and the drainage from the surface complete, so that the surface water will not get down through the pavement or the shoulders to add to the water troubles below.

To meet these requirements, it may be possible to construct a base for the pavement which will be waterproof and flexible enough to follow the motion of the sub-grade, and at the same time cohesive enough to distribute loads over enough area of the sub-base so that there will not be undue settlement on account of the compression of the sub-base. It is possible to construct a wearing surface at the same time waterproof and flexible enough to follow slight movements of the base and still retain its surface practically intact and its ability to distribute loads on its units over the base.

These experiments on macadam bases, while they are incomplete and inconclusive, on account of the neglect to consider conditions and to fit the designs to those conditions, and while they eliminated the most important of these designs from consideration, point the way toward a series of designs and tests of pavements constructed from them which bid fair to be improvements over designs that have been tested, both in quality and in cost.

The apparent drying out of the sub-grade is probably due to the porosity of the broken stone layers rather than any special condition under these sections which differentiates them from immediately adjacent sections. The numbers of the sections show that the concrete section is far from the asphaltic concrete section. The lack of the same action in the macadam under

the brick sections and the lower asphaltic concrete sections is definitely due to the backing up of water on account of the total absence of drainage at that point. Even with the neglect of either surface or subsoil drainage, it seems to be possible for the broken stone layer under the sections located above the depression at the culvert to drain itself and to bind itself with the clay sub-grade close enough to keep its place and do its duty in transmitting loads from the pavement above to the sub-grade below and distribute them so long as they are not excessive, whether the pavement is rigid or flexible. Where the water cannot drain off, the observations and reports show that this distribution of the loads does not occur, but the brick and asphaltic concrete pavements rut badly under the lighter loads of the test runs.

Both the asphaltic concrete and the cement concrete pavements are waterproof until they crack, and the filling of the cracks is a simple and rather inexpensive problem of the maintenance department. Both of them seem to be able to stand the wear of traffic, cement concrete probably being the better in this regard; and the asphaltic concrete pavement is the better able to follow any slight movements of the sub-grade, on account of variations in its condition. The asphaltic concrete pavement and bituminous filled block pavements are not subject to curling up at night.

The writer is working out a design for a base composed of broken stone, the lower portion of the layer to be open and so graded as to carry all water getting into it to outlets located conveniently and frequently. The upper portion of the layer is to be filled with bitumen. On this base any wearing surface can be laid, rigid if condition of subsoil is constant or its movement is slight; flexible, if such movements are great enough to demand it. The wearing surface in any event is to be waterproof and drained to outlets in such manner as to keep water out of the subsoil under or adjacent to the pavement, and enough of the base is to be porous to prevent water reaching the bottom of the wearing surface through capillary action.

The thickness of this base and the proportion of it to be filled with bitumen are questions to be answered with full knowledge of the conditions of the subsoil, and weight and character of loads to be carried as the principal points of consideration.

The tests described above, although woefully deficient, seem to indicate that these thicknesses will not be excessive, and that if the cost of drainage is not excessive, the cost of some design of this sort may be less than one providing for a slab thick enough and with enough reinforcement to answer the purpose of carrying the same loads.

The cost of drainage should really not be considered in comparing designs, because every cent spent in drainage will be returned many times from the savings in cost of maintenance, no matter what the design or the surface material.

To the writer the indications are too definite to be disregarded, that if the brick pavement sections on macadam base, and some of the asphaltic concrete on macadam base, had been located even as favorably as most of the other sections, they would have made a much better showing; also that it would be better policy to change designs to take advantage of the good service given by the broken stone bases where they could perform one of their chief functions (keeping the pavement dry), rather than to lower these conditions to suit those of other sections, which are undoubtedly less satisfactory because the designs of those pavements are less efficient.

BRICK SURFACES

The conclusion from the preceding argument seems to be that the reason for the failure of pavements on macadam bases is, first, the movement of the material in the base course or of the soil underneath, and, second, the ability of the surface to accommodate itself to reasonably slight movements of the same. The application of the latter conclusion is of course to comparatively light loads, proportionate to the strength of the design.

The 8-inch bases were in the water and the brick pavements nearest out of the water were 3-inch blocks on 4-inch macadam base. The tests are therefore of no value so far as brick pavements on macadam base are concerned. They merely corroborate the experience of many years. This applies to Sections 1 to 5, inclusive.

The sections from 23A to 32B, inclusive, had bitumen-filled joints and stone concrete bases from 6½ inches to 3½ inches thick. Most of them were of 3-inch brick, only two having 4-inch brick. Any comparison of lug and lugless brick was negatived by the major operation of cutting a joint in each of many sections, most of which, in the brick pavements, happened to come in the sections or parts of sections laid with lug brick. It may be doubted whether the cutting of this joint was advisable. It is reported to have been done because the expansion of the pavement under the heat of May caused the sections to crowd and thus support each other, and so to increase the strength of the corners of the various slabs. The operation certainly put a stop to the co-operation of adjoining blocks, but it added another line of weakness which apparently increased very seriously the effect of the traffic on the sections so cut. Most of the sections had 1-inch sand cushions, one having 1-inch mastic cushion and one having a 1-inch cement-sand cushion. Most of the bases were of 1-2-3½ concrete, only four being 1-3-5.

Comparisons of sections on any of the points above mentioned show discrepancies and anomalies indicating that some factor or factors of influence have not been recognized in making the designs, and search must be made for them. Close study of these results may suggest possibilities. A preliminary study shows the following, much of which agrees fairly well with the comparisons made in the final "News Bulletin No. 7," issued by the Illinois Division of Highways.

Sections 23A and B, and 24, of 3-inch blocks,

1-inch sand cushion and 6½-inch base, were intact except along the artificially cut joints, and at southeast corner of Section 24, indicating successful passage of test if this outrage had not been perpetrated, even if joints had been properly designed and constructed originally to allow for full expansion. Section 25 with mastic joint was intact. It is probable, as suggested elsewhere in the official report, that shifting of the sand cushion under the disturbance of cutting the joints induced the disintegration started along them.

Sections 26A and B, of 4-inch blocks on 1-inch sand cushion and 4-inch concrete base, were both failures in the official report—A under the second set of loads, and B under the sixth. A was injured in areas extending both sides of the cut joint on the south side and west of the joint on the east side, while B gave very slight indications of failure anywhere. There seem to be no reasons for the difference except the presence of the cut joint.

Sections 27 to 32B, of 3-inch block on 1-inch sand cushion (except 31 on 1-inch sand-cement cushion), on 4½ or 3½-inch base, give results indicating that the unknown factors have more effect than the designed variations. There is some indication that the 1-3-5 concrete of Sections 29 and 32 is not so strong as the 1-2-3½ concrete of the others. Section 31 with sand-cement cushion seems to be in somewhat better condition than the others. The differences in thickness of foundation, 3½ inches in 30, 31 and 32, and 4½ inches in 27, 28 and 29, do not seem to be indicated by the difference in conditions of the sections. The disintegration starts from the cut joints in many cases, indicating probability of movement of sand cushion. The official report shows depression of rows of brick over cracks in foundation before the test was begun, attributed to sand running down into such cracks and leaving brick unsupported. Anomalies in the time that disintegration began to be noticeable are noted in the official report, which were not so definite in an inspection after the tests were finished. The ultimate condition is more nearly proportional to the strength of the design. This may indicate that the assumed movement of the sand cushion is due to various causes and occurs at various times, so that in the course of the tests it produces similar final results, modified somewhat by the other variables. This makes still stronger the argument for a mastic cushion, made in the official report.

Experience on city streets for many years has been such that a brick pavement on less than 6-inch foundation would not be expected to stand under the sixth set of loads, so that here again the tests have told us nothing new. They really indicate that a brick pavement can be constructed somewhat lighter than has been customary, if the traffic is of medium weight, with little regard to its frequency. Five thousand applications of a 10-ton load in 20 days' running time, or even in 37 days of the total time of the last test, is more than 10-inch pavements (4-inch brick and 6-inch base, not including cushion) have been expected to stand in city streets under good drainage conditions. A country road under almost the worst of drainage conditions could not be expected to do as well. The lesson really taught is that a 6½-inch pavement (3-inch brick on 3½-inch concrete base), especially when furnished with a mastic cushion, is equal to the duty which has been expected heretofore of the 10-inch pavement, or even more.

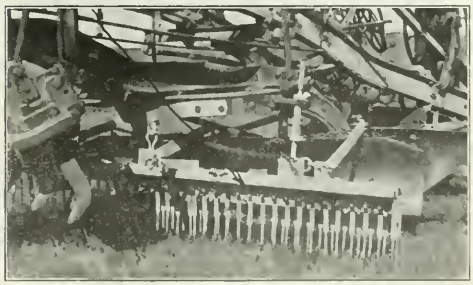
This is indicated also by the tests on monolithic brick sections 33 to 39, inclusive, which vary from 3-inch brick and 2-inch base to 4-inch brick and 4-inch base. However, these sections show the same defects as all the monolithic sections not inordinately heavy, due undoubtedly to the same causes—the expected compression of the unstable wet foundation under loads, especially at the corners of the sections or at intersections of temperature or other shrinkage cracks; and the unexpected curling up of the pavement edges in the cooler parts of the 24 hours.

Here again we have definite corroboration of opinions and observations already fairly well established and indication that such construction is even better than might be expected, especially under the very poor soil conditions of these experiments.

New Method of Gravel Road Construction

In the construction of gravel roads in Oregon and in the reconstruction of old roads a new method has been developed known as the "O'Neil Process." The aim of this process is to eliminate the non-uniformity and the existence of occasional soft spots in such roads by grading the material on the road in an inexpensive manner. In this grading advantage is taken of the fact that larger stones always roll to the foot of a gravel pile. Consequently, if a gravel pile can be advanced progressively across the road, the larger stones continually rolling to the foot of the pile will place themselves automatically at the bottom while the finer material is drawn over them to form the wearing surface.

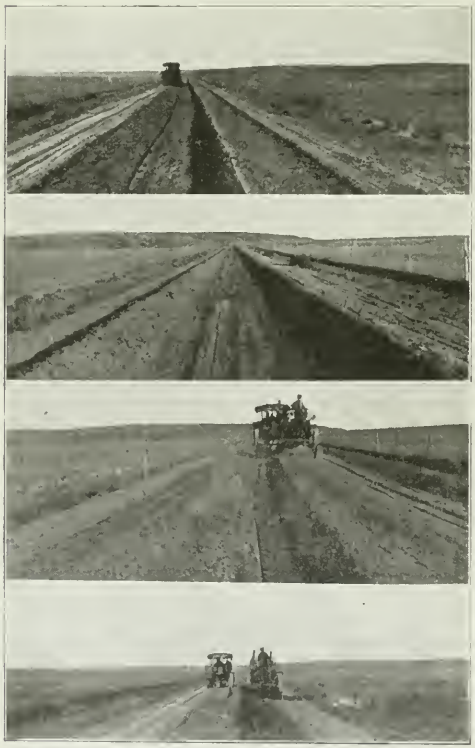
In the O'Neil process the gravel is dumped in



SEPARATOR ATTACHMENT USED IN CONNECTION WITH BLADE AND SCARIFIER

piles or in a continuous ridge along the center line of the subgrade, at least one-half mile of road being treated at a time. A round trip is generally made with the blade grader pulled by a tractor (caterpillar preferred), giving the piles or ridge of gravel a uniform shape and a uniform width of about 8 or 10 feet at the bottom. The ridge so formed is then divided into two ridges as nearly as practicable of the same size by running the blade grader down the ridge a number of times, the two ridges being worked toward the sides of the road until their inside adjacent slopes are approximately 8 feet apart and their outside edges along the line where the finished surface will come, the central valley being carried down to subgrade. A special wing attachment to the grade has been designed by Mr. O'Neil for performing this. While the gravel is thus being worked out from the center it is given a thorough mixing, eliminating all stone clusters.

The two ridges are then worked back over the exposed subgrade by means of the blade grader, but in this operation a separator attachment is placed ahead of the blade, this attachment consisting of two rows of spring steel teeth set staggered on a steel frame suspended from the circle of the grader. These teeth penetrate about 1½ to 2 inches into the surface of the ridges and bring to the surface the stones immediately under it so that the blade pushes the stones forward and they roll to the bottom, smaller stones following in direct proportion to their size and weight. As this process continues the two ridges gradually meet at the center in such a way as to give a uniform depth of gravel over the road, the final operation including bringing all the material, including any that may have been left at the sides, into a center ridge, the base of which covers the part of the subgrade that was left exposed when the two ridges were formed.



BEGINNING DIVISION OF GRAVEL INTO TWO LONGITUDINAL RIDGES
WORKING LONGITUDINAL RIDGES TO SIDES OF ROAD
SPREADING SIDE RIDGES TOWARD CENTER
CENTER RIDGE REFORMED

The process is then repeated in the opposite direction, this center ridge being spread toward the outside, the teeth of the separator bringing to the surface the remaining large stones and permitting them to roll into position on the subgrade.

It is said that when this work is properly done, there results a smooth, uniform gravel surface of maximum density throughout the entire mass. The wear of the road will develop no soft spots or sand pockets because of nonuniformity of material, while the foundation of heavy stones adds to the durability of the road in the same way that a Telford base does to a macadam road. It requires 2½ to 3 days with the grader and tractor for treating a mile of road in this way.

The same process has been used in reconstructing old gravel roads, the roads first being scarified and the gravel scraped into a central ridge. In one case where stones as large as 6 inches were found in the old gravel road, satisfactory results were obtained. It is claimed by Mr. O'Neil that the cost of a gravel road made in this way is even less than a good gravel road made in the ordinary way, since such a road generally requires the screening of the gravel or even putting the coarser stones through a crusher, neither of which is required in constructing the roads in this way.

Utah's Road Problem

Some of the Western States have problems of road financing that can hardly be appreciated by the Eastern States. In Utah, for instance, according to a statement by William Peterson, former state road commissioner and now director of the Experimental Station, only 3% of the land in the state is being farmed and only 18% is privately owned, and yet roads are demanded leading to all parts of the state. The state now has invested in its roads bonds alone amounting to more than $16,000,000 or 2½% of the total valuation of the state.

Mr. Peterson states that money spent in roads depreciates faster than any other form of legitimate expenditure. Investment in an earth road may be absolutely obliterated within five years unless the road be properly maintained. He estimates that the state will have to spend $500,000 a year to protect its present investment in roads of about $18,000,000.

Toll System for State Highways

A proposition was introduced in the South Carolina Legislature for raising funds for highways in that state by charging a toll of 1c. a mile for all passenger vehicles and 2c. for other vehicles. Representative Harper, who introduced it, claims that the amount of the toll would be saved to automobile owners in the cost of gasoline in that "it costs $1.74 per hundred ton-miles to operate on dirt roads and only 71c. per hundred ton-miles on hard surface roads."

It was proposed to issue $40,000,000 of 4½% twenty-year bonds. It was estimated that toll keepers would cost $250,000 a year, giving the total amount to be raised in twenty years as $81,000,000. (Nothing is said about cost of maintenance and repairs.) For income, it is estimated that there would be 100,000 cars and trucks averaging 10 miles a day. Deducting from the annual income, the interest and cost of gate keepers would leave $1,550,000 a year. The total for the twenty years plus 4% interest on the accumulations would give $47,000,000. It is estimated that the number of cars used would increase 5% each year, which would add a total of $49,000,000 to the receipts, giving a total over and above annual expenses of $96,000,000, leaving $56,000,000 after paying off the bonds. It is assumed that at the end of twenty years roads would still have a value at least one-quarter their construction cost.

We have not attempted to figure out just what the effect on the financial statement would be if we allow for the necessary expenditure for maintenance and repairs. Some highway engineers also might question whether there would be even one-quarter the original value of the road left at the end of twenty years.

This idea was presented as an amendment to a bill providing for submitting to the voters the proposition to raise $60,000,000 for highways by bond issue, which was turned down by the Legislature, and it is not probable that the toll road or any other system of raising either $40,000,000 or $60,000,000 for road purposes will come up again at this session.

Atlantic Coast Highway

The South Atlantic Coastal Highway Association held a meeting at Charleston, S. C., on March 15th, at which representatives were present from North Carolina, South Carolina, Georgia and Florida. The association announces that a federal highway from Washington, D. C., via Richmond, Norfolk, Wilmington, Charleston, Savannah, Brunswick and Jacksonville to Miami, hugging the coast from Norfolk to Miami, will probably be a reality by the winter of 1924, "with permanent bridges crossing the streams and rivers between the points mentioned." The association has been working on this project for several years.

New Jersey Highway Work

The State Highway Department of New Jersey reports that, while the 1922 road program provided for the construction of 128.9 miles of highway, the embargo on open top freight cars, delay in obtaining materials, etc., confined the actual construction to 69.3 miles of durable pavement, 3.7 miles of 6-foot shoulders of bituminous concrete and 5.9 miles of completed gravel road, while 50.4 miles were more than 50% completed at the end of the season.

The report states that "while the policy of the department is to construct only hard surface pavements of durable type, it sometimes is necessary to grade and lay a temporary pavement a year or two prior to the construction of the permanent pavement. This is a necessary precaution pending the final settlement of the fills. During the past year 8.8 miles of state highway were thus graded and surfaced with gravel."

The state highway system contains 725.8 miles of road and when the 1922 program is completed 302 miles will be paved with hard surface pavement and of the remainder a considerable amount of bituminous concrete in good condition, but not laid on a rigid foundation.

Gravel Roads in Nevada

Give least annual cost where traffic does not exceed 400 vehicles a day. Recent changes in construction methods.

Nevada has used, in surfacing its roads, gravel, cement concrete, asphalt concrete and asphalt macadam. Up to the first of this year it had completed 154 miles of gravel road, 35¼ miles of cement concrete, 1½ of asphalt concrete, and 3½ of asphalt macadam. Gravel roads therefore greatly exceed in mileage all other kinds combined. The reason for this is explained as follows by Howard M. Log, assistant state highway engineer:

When material is available locally, the cheapest surface to construct is one of gravel. Such a surface, when properly constructed, can be maintained economically and as cheaply as surfaces of higher types provided the traffic does not exceed about 400 vehicles per day.

The contract cost per square yard for gravel surface on eighteen projects contracted in 1922 varied from 29 cents to 85 cents, the wide variation being due principally to the difference in length of haul for the material and the ease or difficulty with which it could be secured from the pit. On four contracts the cost was more than 60 cents per sq. yd., on two less than 40 cents per sq. yd., on eight between 40 and 50 cents and on four between 50 and 60 cents per sq. yd. The average contract cost for all projects was 50 cents per sq. yd.

The approximate cost of other types of surface are as follows:

Asphalt macadam, 6 inches thick, $2.00 per sq. yd.

Asphalt concrete, 6 inches thick, $2.75 per sq. yd.

Portland cement concrete, 6 inches thick, $2.85 per sq. yd.

It is apparent from these figures that, unless

gravel cannot be secured within a reasonable distance of the project or a large traffic is anticipated in the near future, the economical surface to construct is one of gravel. Furthermore, a large part of the state highway system lies in territory where it would be impracticable to construct a "hard surface" without first building a gravel or rock sub-base which would add approximately the cost of a gravel surface to the above costs for higher types. This condition prevails in nearly all of the valley bottoms, such as the Humboldt and Reese river valleys. This same soil is inadequate to carry the traffic that now uses the roads and therefore a surface of some kind must be provided at the time the grading is done. A good gravel surface constructed at this time becomes the base for a higher type surface in the future when the increased traffic requires such a surface.

Surfaces of mine waste, decomposed granite, shale, or crushed rock are considered as included under the heading of gravel surface. Although the cost of a crushed rock surface will usually be more than one of gravel, in some cases ledge or float rock may occur in the vicinity of the project while gravel could be secured only by an almost prohibitory haul.

Prior to 1921, gravel surfaces were constructed of material grading downward from a maximum size of 2½ inches. This size was used because it fitted the available deposits in the State and also conformed to standard practice in other parts of the country. It was found that the larger particles in a surface so constructed continually worked to the surface and were then torn loose, causing the formation of holes and adding greatly to the cost of maintenance. Consequently, the maximum size of the material used has been reduced to 1 inch and the grading and proportioning is being carefully watched so as to secure a uniform material. We note that other states are reducing the maximum size of their material evidently for the same reasons.

It has been satisfactorily demonstrated by this year's construction that the use of a 1 inch maximum size gravel is giving a surface which compacts and binds much better and on which the maintenance will be much less than on the surfaces using a larger material.

It is evident that a much larger percentage of the pit or deposit must be rejected when the maximum size allowed is 1 inch instead of 2½ inches and yet the average cost per square yard for gravel surface was actually less is 1922 than in 1920. This is due to lower costs for labor and materials and to the fact that the contracts were awarded this year on the cubic yard and yard mile haul basis. That is, the contractor receives a definite price for each mile over which a cubic yard of gravel is hauled in carrying it from the pit to the road. Under the specifications previously used, the contractor bid a price per square yard for the surface complete in place regardless of the haul. He naturally increased his bid to cover the contingency of an unanticipated increase in the haul distance and the State paid the increased price whether or not there was an increased haul.

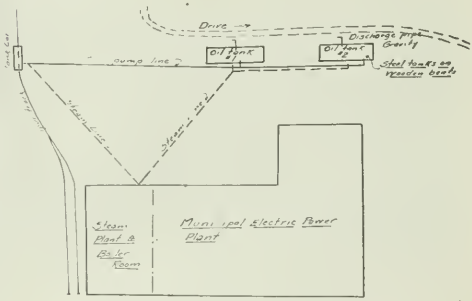
Our effort to remove some of the gamble in highway contracting has borne fruit in dollars saved to the State.

Oil Plant Combined with Power Plant

By O. H. Hampsch

A western Kentucky city of which the writer was an assistant engineer, having decided to establish a municipal oil plant for street oiling, found that it would be of considerable advantage to operate this plant in connection with the municipal electric power plant.

There was available space adjoining this plant which was utilized for the location of the tanks, which were erected here on creosoted wooden bents so situated as to be near the spur track and steam lines of the power plant. This permitted oil in the tank cars to be heated by a steam line from the power plant and the oil to be pumped into the storage tanks. Before the oil was drawn from these tanks it was heated by a steam line from the plant and the pressure was regulated from that point. The tanks were elevated so that the distributors were loaded by gravity from them.



SKETCH SHOWING ARRANGEMENT OF PLANT

In this particular case the power plant afforded a site, an unloading spur, steam for both heat and pumping, and the oil plant was operated by the power plant employees without extra help and with very little additional expense to the city.

The plant was erected by city forces during slack time under the supervision of the engineer of the power plant and the superintendent of streets.

Pennsylvania Highway Transport Survey

The Pennsylvania State Highway Department is planning a highway transport survey as the only accurate basis for estimating the traffic needs of the various roads. This is following out the recommendation of William H. Connell, the assistant highway commissioner, made in his

report last summer for Governor Pinchot. In this he recommended a traffic census taken during the winter, summer, spring and fall seasons on the main or proposed routes and their feeders; a study of the probable future traffic based o information relative to the population, agricultural districts, industries, resorts, etc., to be served by the roads when improved; and a study of the cost of operation of vehicular traffic under different conditions of line or grade. "From this information the economics of the different pavement types for different sections of the highway routes can be intelligently discussed and decisions made on the basis of fitting the types of pavement to the requirements."

Present traffic, he said, is very little indication of what burden will be imposed upon a highway 20 or 30 years from now. What that will be will depend upon the considerations above referred to, but there must also be taken into consideration traffic across the state which will be independent of local conditions, but will be determined by the relation of this road to the routes of interstate traffic.

The Lincoln Highway in 1922

The work accomplished on the Lincoln Highway during the year 1922 is reported by the Lincoln Highway Association as totalling about 243½ miles in the eleven states through which it passes, the cost of new construction having been $4,678,042 and $1,368,126 having been spent on maintenance.

The nature of the new construction varied considerably as well as the cost per mile. In mileage Nebraska leads with 69.6 miles at about $7,500 per mile, while New Jersey leads in the cost of new construction with $1,160,824 for 5.61 miles, or at the rate of nearly $207,000 per mile. Utah alone spent nothing on new construction and its expenditure for maintenance is estimated at only $5,000.

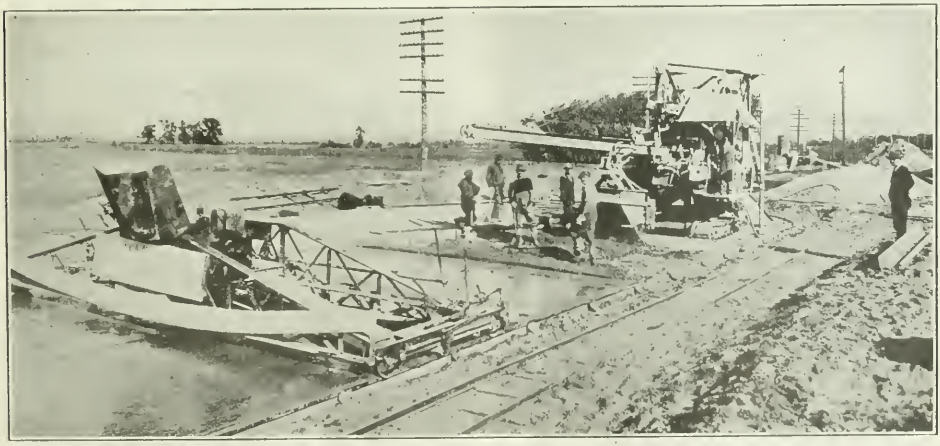
The amount of the different types of pavement completed on the Lincoln Highway last year were as follows: Gravel, 144 miles; concrete, 56.91 miles; brick, 15.13 miles; permanent earth grade, 27.40 miles.

Since 1913, when the highway was first laid out as a transcontinental route, about $47,000,000 has been spent in constructing 3,305 miles. Of this total distance 1,189 is graded gravel and 62 is natural gravel, 578.7 is concrete, 327.8 is bituminous macadam, 287.1 is waterbound macadam, 128.8 is brick, 218.5 is composed of paved city streets and the remaining 513 miles is in earth roads, mostly graded but about 109 miles are still in natural earth.

PAVING IDEAL SECTION

In the January issue of Public Works we gave some information concerning the construction of the so-called "Ideal Section" of the Lincoln Highway. Since then we have received, through the courtesy of the Lincoln Highway Association, some photographs showing work on construction of the concrete pavement of this section.

As stated in the previous description, the pavement was laid in two strips each 20 feet wide. These strips were finished separately by the contractor. The first was finished in the usual way, but in finishing the second strip the contractor fitted the Lakewood finishing machine with a special set of wheels on the end next to the completed pavement, which had a flat tread and travelled on the concrete, while the wheels on the other end which travelled on the side form were double flanged so as to prevent side motion in either direction. The results obtained were considered very satisfactory.



LAYING SECOND LONGITUDINAL STRIP OF "IDEAL SECTION," LINCOLN HIGHWAY

A Hill Road As an Asset

Ordinarily a hill in the line of a highway is considered objectionable, but an instance was recently learned of where, although the highway engineer reported in favor of going around the hill because this would save cost of construction and of maintenance and eliminate an eight per cent. grade, the citizens have petitioned the county commissioners to continue the road over the hill, where it now runs. The hill in question is in Dade County, Florida, a section of the country where hills are so infrequent that even the difficulty of climbing is considered to be more than offset by the "pleasant surprise to people coming by this route who thought Florida nothing but low, flat lands."

Gasoline Tax in Several States

General approval of it by the public, the arguments that led eleven of the states to adopt it, and methods of collection.

The Department of Highways of Nevada, during the latter part of 1922, while studying the question of raising state highway funds by taxing gasoline, obtained opinions of the highway officials of several states that had already adopted this plan, which it summarizes as follows:

GENERAL ATTITUDE OF THE PUBLIC

ARIZONA—"We believe that the one-cent gasoline tax levied by the State of Arizona has worked out very well and that there is no general complaint in regard to it."

ARKANSAS—"The present attitude of the public towards this tax is one of approval."

COLORADO—"The present attitude of the public is very decidedly in favor of it."

CONNECTICUT — "Naturally some adverse criticism has been made in this matter. The general public, however, has no complaint to make, the amount of the tax for a year being comparatively small for the average car user."

KENTUCKY—"On the whole it appears that the citizens of the State have recognized the justness of the gasoline tax."

MARYLAND—"There is enthusiastic and universal approval of the gas tax by the public. In fact, the legislation was passed at the last session of the Assembly without a roll call in either House or Senate. Since its advocacy before the legislature, we have not heard a single objection to it by anyone."

MISSISSIPPI—"We believe that this bill has the approval of the people."

NORTH CAROLINA—"There seems to have been no objection whatever by the public to this tax."

PENNSYLVANIA—"Strange as it may appear, little or no protest was made against the passage of this act."

SOUTH CAROLINA—"There is general approval of a tax on sales of gasoline."

SOUTH DAKOTA—"There seems to be but very little complaint on the part of the public towards paying the tax."

WASHINGTON—"The public apparently favors this tax."

ARGUMENTS WHICH LED TO ADOPTION OF TAX

ARIZONA—"In this State the tax on gasoline has proved a very satisfactory means of raising money for road purposes. In our opinion the gasoline tax will shortly be nearly universal, and that State lines will not interfere with its operation."

ARKANSAS—"The principal argument for the adoption of the gasoline tax is the fact that this tax is the most equitable one that can be devised to force the users of our roads to bear a part of the cost."

COLORADO—"The necessity of roads and the fact that it is paid by those directly interested in better road facilities."

CONNECTICUT—"The adoption of the tax was due largely to the need for increased revenues. It has also been argued that this tax is more equitable for motor vehicle users inasmuch as it is directly proportionate to the use of the road and the weight of the vehicle."

KENTUCKY—"Gasoline tax was adopted in Kentucky for the reason that the large part of it was consumed in automobiles, which were believed to be the most destructive agents of our limestone highways. The idea was to place the cost of construction, reconstruction and maintenance on those who are actually wearing out the highways."

MARYLAND—"In the little State of Maryland we are collecting about $2,500,000 from motor vehicles in direct taxes, and it certainly has become a real business, and should be treated in a business way. By this we mean that every user of the road should pay for the service which he receives, no more, no less."

MISSISSIPPI—"The biggest argument used in favor of this tax in this State was that inasmuch as the automobile is the most destructive agent of the roads, the automobile owners should pay a larger part of the cost of maintenance."

OREGON—"It has the advantage of procuring some revenue from the tourist who is exempt from motor vehicle fees, and it is also an equitable tax from the fact that the tax is in proportion to the use of the roads."

SOUTH CAROLINA—"The tax on gasoline was imposed by the Legislature at its session in 1922 in response to the demand that the tax on real property be lessened and that the users of gasoline contribute to the construction and maintenance of the roads."

SOUTH DAKOTA—"The law was passed by the Legislature with very little argument on account of its being realized that the tax is equitable."

WASHINGTON—"It was urged in behalf of the tax that it placed the burden of highway construction upon those who primarily derived the chief benefit from the existence of highways."

METHODS OF COLLECTION

ARIZONA—"The tax is made at the wholesalers, which means that the cost of collection is very small."

COLORADO—"We collect the tax from the wholesalers shipping in bulk. The attempt to collect from retailers would be an expense and not effective."

MARYLAND—"Our gasoline tax is collected from the importer or refiner, before it is offered for sale in this State. By this method we have only about twenty 'dealers' in the State, and the question of collection is greatly simplified. This method has given eminent satisfaction, and there seems to be no objections whatever to it, and really, there seems to be no other logical place at which the tax can be collected. If, as in one or two States, it is collected by the State from the filling stations, the general seller to the ultimate consumer, your dealers run into the thousands with the attendant extra expense because of the smaller quantities sold, and the attendant loss from the percentage of dishonest dealers."

Conclusions from the Pittsburg Test Road

Tentative conclusions from latest tests show importance of sub-grade conditions, strength of thin slabs, and the importance of absolute smoothness and thickened edges.

The construction of a test road at Pittsburg, California, and some of the results obtained have been described in Public Works for October 29th and December 10th, 1921, and for January 14th and February 11th and 18th, 1922. Results of tests made subsequently will be published in detail in the near future by the U. S. Bureau of Public roads and the California State Highway Commission. In the meantime, tentative conclusions derived from these statistics have been made public by T. E. Stanton, assistant state highway engineer of California, in a paper before the American Association of State Highway Engineers. In the following abstract of this paper we have endeavored to give briefly the more important points presented by Mr. Stanton:

"One of the most astonishing results of the Pittsburg test was the ability of the thin slabs, even the 5-inch, to withstand severe punishment..

"This was undoubtedly due to a very large extent to the care with which the subgrade was constructed and any discussion of design must therefore take into consideration specifications for subgrade treatment as well as the design of the pavement section.

"The outstanding determinations may be summarized as follows:

"1. Thorough and proper subgrade treatment is the first prerequisite of success in pavement construction.

"2. Assuming proper subgrade preparation even the 5-inch slab will stand up under a large volume of truck traffic without serious deterioration.

"3. The thickened edge increases the strength of the thin slab to a very considerable extent and can be economically justified, especially from a maintenance standpoint.

"4. Absolute smoothness, especially at joints, is essential if the pavement is to withstand the hammering of solid tired trucks.

"It may be said that the above determinations add little to our previous knowledge as for some time highway engineers have known that proper subgrade treatment and care in the finish were essential factors in the success of any pavement and especially of the thin slab; also, that the thickened edge is a decided advantage.

"The extent of the part which these factors play in the successful design, construction and maintenance of concrete highways has, however, been forcibly brought to attention as a result of the above tests."

PREPARATION OF SUBGRADE

This pavement test was inaugurated by the Columbia Steel Company with a view to developing a market for a special high-grade steel used as reinforcement. The thirteen sections selected for investigation were suggested by federal, state and county highway engineers. The first series of tests made by this company was completed in January, 1922, and a second series was started in June by the U. S. Bureau of Public Roads and the California Highway Commission, these tests continuing through July and a part of August.

In the construction of this road special pains were taken with the subgrade. The road was built on black adobe soil, and in order to secure conditions as nearly uniform as possible the site of the road was levelled off to a grade three feet below the finished subgrade and then built up to a height of three feet by layers of earth spread nine inches thick, loose measurement, thoroughly harrowed and pulverized and then compacted with a 12-ton roller to about six inches thickness; each compacted layer being scarified to a depth of two inches before application of the succeeding layer. After the completion of this embankment, header boards were set true to line and grade and the material between them was scarified to a depth of six inches by a subgrade machine and the excess dirt removed to approximately 1½ inches above subgrade. The subgrade was well scarified to a depth of two inches, water sprayed on and then rolled. While still moist, the subgrade was dressed off with the subgrade machine to the correct elevation, following which it was sprinkled lightly each day until the pavement had been laid, to prevent cracks forming in the soil.

DESIGN OF PAVEMENT

California had built many miles of five-inch concrete pavement and also a considerable extent of four-inch pavement which was then and is still giv-

ing service after ten years' use. It was therefore decided to test thin concrete slabs in this road. Among other sections was one known as the "Arizona type" which had a uniform thickness of six inches except for two feet from the edge, which gradually increased from six inches to nine inches at the edge. (This is apparently the same section that was last year adopted by the Illinois State Highway Department.) The idea of thickening the edges of concrete pavement was by no means new. About 1910 the Highway Commission of Wayne County, Michigan, constructed "inverted curbs" or beams along the edges of their pavements. This was later concluded to be a mistake in that the moisture apparently was held under the pavement by the curb and, in freezing, broke the curb from the body of the pavement. California in 1912 adopted a thickened edge as an alternate type, the curb or beam being wedge shape. Both the Arizona type and the inverted curb type, and thicknesses varying from five to eight inches, were included in this test road.

TESTS MADE

During the first test ending January 28, 1922, 3,672,730 tons passed over each section of the road and none of them had completely failed, although it was found necessary to make rather extensive repairs on portions of the five-inch slab. During the second series, conducted by the U. S. Bureau of Public Roads and the California Highway Commission, 3,690,000 tons passed over the road. In this test the minimum gross load used was 14,500 lbs. while the maximum ordinary gross load was 27,000 lbs. and the average was approximately 24,000.

At the conclusion of this test the pavement had not failed sufficiently and it was desired to make a further test to determine the tonnage required to cause complete failure of the different sections. Accordingly, a super test was carried on for seven days. In this a two-wheel trailer carrying a load of approximately 16 tons made 105 circuits and a few places were shattered on the 5-inch sections. The trailer was then loaded to approximately 30½ tons and there was a general shattering of the 5-inch sections under the rear wheels in many places, except that one 5-inch section that was reinforced top and bottom was not seriously affected. The trailer was then loaded to 50 tons and cut entirely through a 5-inch section and stuck there. It was then unloaded to 35 tons and made three circuits, which resulted in a continuation of the shattering of the 5-inch sections, but the other sections were not appreciably affected. The load was then increased to 40 tons and the two circuits made, during which the shattering of the five-inch sections continued. It was then loaded again to 50 tons and three circuits were made, the rear wheels cutting two furrows almost entirely through all but one of the five-inch sections, the one reinforced top and bottom being cracked only slightly and showing only very little shattering. Two sections 6 inches thick and reinforced top and bottom were shattered very little. A six-inch section with thickened edges but not reinforced was almost unaffected. Except one 5-inch section, all sections that carried inverted curbs and no reinforcement were practically unaffected. The trailer carrying the 50-ton load was equipped with dual 5-inch steel tires and on all of the slabs slight abrasion of the surface was noted.

CONCLUSIONS

The first set of tests, which ended in January, 1922, was of medium to heavy traffic on solid tires and is estimated to have been equivalent to similar average traffic over the California State Highway system of from 25 to 40 years. This is based on traffic census of California highways taken by the Bureau of Public Roads. The bulk of the traffic so enumerated was of course on pneumatic tires and the results at Pittsburg indicated that any amount of this kind of traffic does a relatively small amount of damage to such pavements.

Said Mr. Stanton: "Where a 5-inch base with edges thickened to 7 or 8 inches will carry all the traffic which can reasonably be expected for a period of twenty-five to forty years without excessive injury, the construction of a 6-inch slab with 9-inch edges is of questionable economy; especially in view of the fact that in the event of an unexpected increase of damaging traffic on a part or all of a section, an asphalt surface can always be added." In California, where the subgrade conditions are bad either the subgrade is treated or the pavement is made not less than 6 inches thick or both; but where the traffic is comparatively light and subgrade conditions satisfactory, a 5-inch base with 7-inch thickened edge is being constructed. A study of bids received for constructing concrete pavements in California appears to indicate that contractors there bid practically as much a cubic yard for a concrete pavement six inches thick as for one five inches thick.

One important conclusion from these tests resulted from the observation that "all the failures originated at points where slight inequalities in the pavement occurred, and extended rapidly around the fractured area if they were not promptly repaired. In general, it may be stated that with a rigid type of pavement such as the Portland Cement concrete type, absolute smoothness of surface is an essential requisite."

Standard Specifications for Missouri Highways

The State Highway Commission of Missouri has issued new standard specifications governing state road and bridge construction which supersede those issued in May, 1919. Instead of furnishing a copy of these specifications with each contract or for each job on which bids are invited, copies have been sent by B. H. Piepmeier, chief engineer of the Commission, to contractors, equipment companies and other interested parties with the request that they keep them in their files for future reference. In the future the Department will furnish to prospective bidders the special provisions that are bound in the proposal form but not the standard specifications. This is expected to result in considerable economy in the publication and mailing of specifications to the numerous bidders on state highway work.

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Adequate Maintenance or No Construction

"Unless adequate maintenance is provided for, initial construction of highways should not be undertaken at all." This unqualified assertion of a committee comprising nine of the most prominent state highway commissioners and engineers of the country, assembled in Harrisburg last month, is perhaps the most important sentence in that committee's summary of the conclusions of the Harrisburg conference.

This idea is emphasized by the Bureau of Public Roads in its regulations for the allotment of Federal aid, whereby a state is required to provide adequate maintenance of all F. A. roads. Because of failure to do so and to maintain an adequate highway department, Arkansas has been denied Federal aid this year, and very properly so.

A road begins to depreciate by the end of its first season. If the road is properly maintained, the depreciation can be kept at a fairly uniform and moderate amount each year; but if it is not, the rate of depreciation increases rapidly and practical destruction is sure.

The country has invested several thousand million dollars in improving its roads, and is increasing this at the rate of nearly a billion dollars a year. Part of this is permanent improvement —grading, bridges, etc.; but, perhaps half is subject to rapid depreciation and if adequate maintenance is not provided will be totally lost within five or ten years, while meantime an increasing percentage of the investment fails to give adequate return in the shape of benefits to traffic.

If only a fixed amount is available for highway purposes for several years to come, this should be so apportioned by the wise judgment of a highway expert that each year will find available for maintenance an amount sufficient for the proper upkeep of all the roads that have been improved up to that year; due allowance being made for the increase in traffc that will certainly follow the improvement.

Dirt Roads

There are more than two million miles of roads in the United States that are just dirt roads—not even a gravel or sand-clay surface. Some of these are on trans-continental routes, many are on interstate routes, but most are little-traveled country roads. Although the mileage of improved roads is but a fraction of that of dirt ones, the ton-mile and even vehicle-mile traffic is undoubtedly much greater and the improved roads do and should have more public funds spent on them than the dirt roads.

But this does not mean that the dirt roads should be neglected and the taxpayers who must use them receive no consideration. If the improved roads average 500 vehicles per day over each mile and average $3,000 a year for maintenance and depreciation, while dirt roads average 5 vehicles a day, equal consideration would call for $30 per mile per year for maintenance—not much, but $30 more than the greater part of them receive.

More attention should be paid to the improving of dirt roads, by shaping, planing, and inexpensive surfacing with gravel or other local material. We believe that if engineers turn their attention seriously to this problem it will be found that great improvement can be obtained at moderate cost. An encouraging indication is the annuncement that the Department of Civil Engineering of the University of Illinois is conducting experiments and an investigation of this subject. A report of results has recently been made, which we expect to abstract in an early issue.

Morals of Municipal Contracting

Under the above title the official publication of the Contractors' Association of Philadelphia, has published an editorial calling attention to the injustice and one-sidedness of the contracts under which contractors are required to do work for the city of Philadelphia. The chief point of complaint is that the contract makes the engineer the arbitrator in misunderstandings between the contractor and the city, stating that "the contract is fundamentally unfair, and further is intentionally unfair in that the whole effort is to prevent the contractor from asserting any right that he has, and intentionally unfair in attempting to compel him to adopt constructions and decisions made by the other party to the contract, whose interest is adverse."

As a remedy, the organ of the Contractors' Association suggests that a city ordinance be adopted requiring the contract to give the contractor the right to appeal from the decision of the city engineers if he feels he has been aggrieved; this appeal to be settled either by arbitration or by the courts. "This would not in any way interfere with the progress of the work because such specification could provide that until the work was completed the contractor would be absolutely bound by the orders of the city, but if such orders required him to do more than his contract, then the city would have to pay the extra cost of the work which the contractor has been required to do."

Correspondence Course in Drafting

The National Vigilance Committee of the Associated Advertising Clubs of the World calls attention to the advertisements of Chief Draftsman Dobe "as being misleading" and the American Association of Engineers is warning its members against his advertisements. The Vigilance Committee reports that, according to these advertisements, "a 15-year-old boy with ability to read, write, use figures and follow instructions, can study under Dobe for the equivalent of three to six weeks of solid 8-hour days and then be prepared to earn, and in fact is guaranteed, a salary of $250 to $300 a month with $450 on the side at home. A magnificent set of drafting tools are advertised free as an inducement to prospective students. However, the approximate sum of $65 is charged for the course and must be paid before the free tools become the student's property."

Of course, no one at all familiar with engineering would place any confidence in these statements, but a great many young men must be misled, for these advertisements have appeared for a number of years, one in Popular Mechanics magazine consisting of two full pages costing $1,150 per issue on a yearly contract basis. The National Vigilance Committee was assisted in collecting the data for its report by a committee for the Chicago chapter of the A.A.E. consisting of W. A. Artingstall, Paul Hansen and Robert W. Shelmire.

Engineering Positions in Civil Service

Advantages offered, positions open and salaries paid. Statement of Civil Service Commission.

The U. S. Civil Service Commission a few weeks ago made public for general information a letter addressed to Prof. J. C. L. Fish, of the Department of Civil Engineering of Stanford University, giving, in reply to his inquiry, very complete information concerning civil engineering positions in the servicie of the Federal Government.

Data compiled by the commission show that there are approximately 2,000 civil engineering positions in the Federal Civil Service. These are in various departments and bureaus, and the designations of the positions are by no means uniform in the several departments. The list of civil engineering employees shows 636 in the War Department, 9 in the Treasury, 446 in the Interior, 125 with the Interstate Commerce Commission, 396 in the Department of Agriculture, 106 in the Commerce Department, 22 in the Navy Department and 24 in the Postoffice Department.

In the Navy Department the salary ranges from $6.72 a day to $14.16 a day; in the Department of the Interior the salaries are by the month, ranging from $100 to $300. In all the other departments the salaries are by the year and range from $1,000 for topographic draftsman in the Interior Department to $9,000 for civil engineer with the Interstate Commerce Commission.

The letter states that vacancies are constantly occurring in the Federal Civil Service and there is never a time when there are not openings for civil engineers. Special attention is called to the positions of junior engineer and deck officer under the U. S. Coast and Geodetic Survey, there being practically always a shortage of eligibles for these positions, although the entrance salary is $2,000 and the position can be obtained immediately upon graduation from an engineering school. In explanation, it is found in the requirements for these positions that the applicant must have been in the upper half of his class in each of the major subjects on which his selection is based, for his entire collegiate course. Men who cannot meet this requirement are not even considered. Moreover, he must obtain an "A" standard in physical examination.

Concerning the advantages claimed for Government employment for civil engineers, the Civil Service Commission mentions the following:

"The Government service offers a wide field

where individual tastes may be developed and where real constructive work—big interesting, clean work—may be done. Probably it cannot be said that under present conditions employment in engineering positions under the Government is as lucrative as the same employment in private industry. Nevertheless, the civil service has much to commend it.

"Not the least of the advantages of Government employment is to be found in the opportunity it affords for useful public service. Further, it increases one's scientific knowledge and training through contact with a large number of highly trained men. The experience gained by a young engineer in Government work might be classed as a post-graduate course. The opportunity to meet and profit by the experience of engineers who stand high in their profession is excellent, both in the field service and in Washington. The assignment to different fields, which are often possible for the young engineer, add to his education, for they bring him in close touch with many phases of engineering work and acquaint him with local conditions as they apply to various engineering problems. This opportunity for travel and study is one of the greatest inducements for entering upon Government work.

"Advancement in the service depends upon the degree of ability displayed and, of course, upon the needs of the service. It is assured that ability will be recognized by advancement in grade and salary wherever possible.

"Aside from advancement within the service, many recent graduates enter the Government service because of the well-founded belief that a few years of experience in Government work will be of material aid in securing good positions in the industries.

"Less important advantages of Government work are the thirty days' annual vacation leave, thirty days' sick leave in meritorious cases, retirement with annuity, and benefits under employees' compensation acts in case of injury incurred in the performance of duty. It may further be said that Government employment offers a better prospect of steady work than does private employment generally."

Applications for the position described above as "junior engineer and deck officer" will be received until June 30th of this year. Other openings at the present time are for positions with the Bureau of Standards of engineer at $2,800 to $4,000 a year; associate engineer, $2,000 to $2,800 a year, and assistant engineer, $1,500 to $1,800 a year; applications received until further notice. Also, with the Interstate Commerce Commission, junior engineers at $1,320 to $1,980; applications received until further notice. Also copyist topographic draftsman at salaries ranging from $1,140 to $1,640 a year; applications received until further notice.

Vigo County's Experience with Vibrolithic

Probably many of the readers of Public Works know little about the kind of concrete pavement called vibrolithic, and on learning that Vigo County, Indiana, had laid considerable of it and epected to lay ten miles more this year, we asked Mr. Gibbons to describe his experience with it. In response he has sent the following letter:

Public Works,

Gentlemen:

We are contemplating the construction of approximately ten miles of Vibrolithic concrete pavement in this county, during the coming Summer. We have at present let four miles, the bid price per square yard being $2.09, which is much lower than the State Highway Commission is getting upon their plain cement concrete pavements which they have let so far this season, their prices per square yard ranging from $2.42 to $2.60, and this is practically the same thickness of slab that we have.

This county constructed, in 1918, one and one-half miles of Vibrolithic for $2.65 per square yard, in 1919 about the same mileage for $2.76 per square yard, in 1920 and 1921 we completed about 14 miles, the cost being from $2.69 to $2.94 per square yard. These pavements are all in good condition—some cracks of course, but nothing serious. We keep them poured, or rather the contractors do, as we have a five-year guarantee upon all of this construction. It is impossible with this form of construction to get quite so smooth a wearing surface as with the plain cement concrete pavements, but these pavements are wearing much smoother every day, and from appearances and reports, they are so far getting into better shape each day.

The Vibrolithic process really means nothing more than a well tamped concrete. In all this construction, any one can walk upon the slab immediately after the vibrator has passed over, without going into the concrete any deeper than the cement float, that is very seldom over the thickness of the shoe soles; so from that you can get some idea of how the concrete has been compacted by vibration. We have had a great many tests made privately at Purdue University, with plain slabs, and with vibrated slabs with and without the top coating of gyranite, trap or boulders, and at all times the vibrated specimens were much superior to the others. R. C. Yoeman, secretary and engineer of the Indiana Gravel Producers' Association at Indianapolis, Indiana, conducted most of these tests while he was connected with the College of Engineering at Purdue University.

All our specifications covering Vibrolithic pavements have been approved by the Indiana State Highway Commission. We build the slab six inches thick and 18 feet wide with a two-inch crown. The concrete slab is composed of plant-mixed gravel, carrying from 65 to 70 per cent. of gravel ranging from 1/8 inch to 2 inches in diameter, the sand being below 1/8 inch in diameter. By being able to use the plant-mixed material in this process, we save quite a sum of money for gravel and sand over the prices that we would have to pay for the separate aggregates; also our cement content for a cubic yard of concrete is 1.30 barrels, this also makes a saving in cement. However, we vibrate a layer of granite, trap or crushed boulders in or over the top of the green concrete to the amount of sixty-three pounds per square yard or about one and one-half inches in depth, this makes in all about seven and one-half inches in depth of materials used, and the slab is compacted or vibrated to a finished thickness of six inches.

We put in expansion joints about every thirty-three feet, cutting through the top three inches only, allowing the slab to crack underneath. The joint is filled with a prepared asphaltic material and vibrated into place, thus practically sealing the joint.

Our Vibrolithic pavements at present range from nearly five years to one year in age, and I can truthfully say that the older pavements are better in every way than the newer ones, and are still getting smoother. The mortar float finish is wearing off and the traffic is now rolling upon the granite wearing surface and smoothing up nicely; in fact, I am very much pleased with the result, and would indorse this type of pavement anywhere and at any time. I believe in it.

Yours truly,

ROBT. E. GIBBONS,
Vigo County Engineer,
Terre Haute, Indiana.

Abuse of Separate Sewers and Storm Drains*

Suggested remedies include care in selecting system, zoning, municipal construction of connections, and co-operation between municipal departments.

Great care should be exercised in the selection of the type of sewer system to be installed. It should not be assumed that separate sewers are more advantageous, but conclusion should be reached only after careful study of all the conditions, including comparative estimates of cost. In making such studies due weight should be given to the value of the opportunity for disposal of roof water into sewers and to the inequity of affording such facilities to a portion of the property owners and withholding them from others. It may be accepted as a fact that residents will not tolerate standing water in their cellars. In thickly settled communities water cannot be allowed to flow over sidewalks to the street gutters, and, at least in the northern portion of the country, roofs and areas cannot satisfactorily be drained into gutters by pipes passing under sidewalks. Topography, character of soil, climate, present and prospective density of population, frequency and intensity of precipitation, as well as conditions influencing the problem of sewage disposal, are among the important considerations bearing upon such a selection.

It is possible that the zoning system, which is now being favorably considered in many American cities, will simplify the problem of determining the character of sewerage and drainage works to be provided. Whereas formerly it was impossible in many instances to forecast with accuracy the character of development which was likely to take place in the different portions of a city or to provide systems to meet all contingencies, the zoning system now facilitates more accurate forecasting of future sewerage and drainage requirements and there is greater assurance that the assumed future conditions will be realized.

The so-called "English system" has been advocated by some. In this, allowance is made in the separate sewers for such roof water as abutters may choose, or may be permitted, to discharge into them. In some places the unlimited disposal of roof water in this manner would result virtually in a combined system, since roof areas may well equal street areas, and where the community is thickly settled the extent of roofs may be three or four times that of the streets. It is doubtful, therefore, if the "English system," so-called, is of very general application. It must be conceded, however, that some extraneous water will reach separate sewers. Some roofs will be connected through error or surreptitiously. Some cellars will be drained, and some defective connections with sewers are inevitable. Reasonable allowance must therefore be made for such conditions.

Far greater care should be exercised in the construction of separate sewers than has been the case in many instances, in order that the sewers may not become overtaxed because of large quantities of ground water entering them.

Greater effort should be made to secure excellency of workmanship in the construction of house connections. In many cases sewers have been laid in an excellent manner and have been reasonably watertight. Later, however, through carelessness in the making of house connections these systems have been subjected to serious abuse. Mr. Dittoe* has suggested that,—

> . . . The most logical and effective method of accomplishing this is the construction by the municipality of all connections to the public sewers from the building to the street sewer and the continuation of municipal control over such connections after they are constructed. The sewer department would organize its construction gangs for this work or would enter into annual contracts with responsible contractors, and the property owner would pay to the city the cost of construction, inspection, and recording.
>
> . . . It is believed that this method of construction would insure better construction of the connection at lower cost, would largely prevent the misuse of sewers, and would assist in securing efficient operation of sewage treatment processes. Incidentally, it would probably arouse a more lively interest on the part of the city officials in the management and maintenance of the sewerage systems and would likewise remind the public that the system is an important feature of the community development and must be controlled in a business-like manner if its value is to be realized.

There is much to be said in favor of Mr. Dittoe's suggestion. Where connections are made by contractors, however, they should be licensed annually and should give bond for the faithful performance of their work.

More effective control of the construction and maintenance of house connections should be secured in many cases. Generally such control should be vested in the official in charge of the sewer system. When connections are to be made written applications therefor should be filed, and written permits for the connections should be issued. The official in charge should be notified when the work is to be done and should provide for the necessary inspection. A record of permits issued and used should be kept in a book provided for this purpose. The inspector's work should also be made a matter of record.

A few years ago the author had opportunity to observe the character of construction and inspection of house connections in Manchester, England. In this case the connections were completed before the inspector visited the work. The pipe line, however, was left entirely exposed, including the portion of the public sewer affected by the connection. Upon arrival of the inspector a plug was inserted at the branch in the main sewer and the connection subjected to slight hydrostatic pressure. In this instance there was no measurable leakage. Obviously, the connection was approved.

*Continued from page 95.

*Proceedings Am. Soc. C. E., December, 1921.

Co-operation between certain municipal departments is very important in securing satisfactory plumbing and house connections. The extent of such co-operation and the departments affected depend upon the local system of conducting the municipal work. The department which has charge of plumbing inspection should require the filing of sketch drawings showing the work contemplated. Before issuing permits for such plumbing these drawings should be submitted to the official in charge of the sewers, for his approval. If the drawing shows erroneous connection of roof water and fixtures within the building, the sketch should be returned to the plumbing contractor for the necessary revision. Until the drawings have received the approval of the sewer official the plumbing permits must not be issued. It is necessary that the plumbing inspectors understand the importance of the separation of roof water from sewage and that they shall conscientiously carry out the regulations to that effect.

It is also advisable to provide against incorrect connection made through error. In the City of Philadelphia the usual sewer and drain connections are 5 inches and 6 inches in diameter, respectively. Thus it is easy to determine with which pipes the plumbing systems should be connected. In another instance the bells of the cast iron pipes inserted into the foundation wall by the drain-layers are painted white in the case of storm water drains, and black in the case of sewers.

Complete and accurate records and record drawings of all sewers and drains should be filed in the municipal offices in a manner which will make them readily accessible for reference. As suggested by Mr. Dittoe, instructions as to the proper use of the systems should be provided by the engineers having in charge their design. Such instructions should be in permanent form and so placed, filed and disposed as to be always in evidence and available. Wall maps, house connection application blanks, permit books and permit blanks should have displayed prominently upon them the proper restrictions upon the use of the sewers and drains.

Suitable statutes or ordinances should be enacted to provide for the proper regulation of house connections. It is expecting too much of city officials to rely upon them to enforce such regulations unless they are specifically set forth in the state laws or in the municipal ordinances.

While much can be accomplished by such measures as have been suggested herein, after all, the success of systems of separate sewers and storm drains must depend primarily upon the integrity, loyalty, knowledge and backbone of the city officials in charge. They should recognize that it is one of their important duties, for the faithful performance of which they have taken oath, to see to it that the sewer and drainage systems are not misused and abused. There is no doubt that in many instances the strict performance of their duty will be unpleasant. In certain aggravated cases such performance of duty will doubtless result in a search for a new position. Nevertheless, it is the author's firm conviction that in many cases systems of separate sewers and storm drains can be saved from failure only by the loyal performance of this duty by the city official upon whom the responsibility devolves.

DISCUSSION OF THE PAPER

In discussion of this paper, A. Prescott Folwell presented some information obtained for him by the Clearing House of the society tending to show the extent of the misuse referred to. The replies were classified and combined as follows:

SEWAGE INTO DRAINS

The question was asked to what extent sewage from houses or elsewhere is discharged into storm water sewers (or drains) either under permission or regulation, or surreptitiously. Fourteen cities replied that this practice was not permitted; six that it was permitted, a seventh that it was permitted under temporary permit of the Board of Health in streets that were not yet sewered; and two that it was permitted under regulations. As to whether this was practiced surreptitiously, nine stated that it was to a small extent, one that about fifty instances could probably be found and seven that there was no such misuse.

To the question, to what extent industrial or objectionable wastes are permitted to be discharged into storm water sewers, nine replied that this was permitted, ten that it was not permitted, one that it was permitted for laundries; while to the question whether this was done surreptitiously, four stated that it was not; four that there was a greater or less amount of such misuse, and another that it was confined chiefly to garages.

Some industrial wastes are known to interfere with the treatment of sewage, and to the question as to the discharge of such wastes into sanitary sewers seven replied that there was no such discharge in their city; four that there was more or less, while a fifth specified two creameries, a sixth a gas plant, and two others stated that all industrial wastes were discharged into the sanitary sewers. In the case of combined sewers, eight stated that there was no such discharge; four that there was a slight amount, and two that all wastes reached sewers. Eight reported that discharge of these materials was done under permission and regulation by the city, four stated that no such discharge was done surreptitiously and five that there was more or less surreptitious discharge of such materials.

As to the kinds of industrial wastes reaching the sewers, three reported that wastes from tanneries and glue factories containing hair and lime reached the sewers; three reported wastes from textile industries containing cloth, fibrous material and objectionable compounds and solutions; three reported wastes from canning factories; two from stockyards; six from packing and rendering plants; one from wool-washing plants; four from dye works; ten from cream-

eries; three from gas factories; eleven from garages and two acid wastes from metal factories.

STORM WATER INTO SANITARY SEWERS

The question was asked to what extent roof leaders and area drains discharge into sanitary sewers. Four replied that such use was permitted; thirteen that it was not permitted, and two that there were a certain number of cases permitted. Four said that there was no surreptitious practicing of this, and seven that there were a few instances, but several others reported that "many" had infringed, "a vast number," "hard to control," etc.

The admission of sub-soil drainage to sanitary sewers from cellars, foundations, etc., was reported as permitted in seven cities, as not permitted in one city and as not practiced in six cities. The amount entering the sewers from leaky joints was reported to be none in two cities, small in one city, while others reported that it amounted to about 20 per cent. of the flow, 10 per cent. to 15 per cent., "considerable," "quite extensive," and others stated that it was "difficult to avoid," "difficult to determine," "unknown," etc.

In some cities storm water is admitted through inlets to the sanitary sewers, either from streets or other public thoroughfares, or from ditches or other open water courses. Fourteen reported that no storm water was admitted from streets, one reported that it was so admitted from all paved areas, five that there were some instances of it, and two that there was only one such instance. Admission from ditches and open water courses was reported from only two cities.

In general, the replies indicated a greater amount than had been suspected of permitted use of the different classes of sewers for purposes for which they are not theoretically adapted and which the writer believed are objectionable and should be eliminated wherever it is at all possible. As already stated, there is probably a great deal of surreptitious misuse of sewers in the manners indicated of which the authorities have no knowledge, but which should be discovered and stopped. In view of the millions of dollars invested in sewers and sewage- treatment works, this subject has not received the attention which it deserves from municipal authorities.

Catch Basin Cleaning in Chicago

Chicago continues to afford an illustration of how many cities of the country waste money by constructing worse than useless catch basins. The latest report of the Bureau of Sewers of that city shows a total of 128,596 catch basins in the city, while during the year covered by the report there were only 47,939 cleanings of basins performed.

This means that at least 100,000, or 75 per cent. of the basins, perform no service; for if a given basin is not cleaned at least twice a year, either it does not receive enough dirt to warrant its being there, or else it is full most of the time and does not function as a catch basin. In either case, the money used in building the catch-basin feature of the inlet was wasted, and the sediment that stays there indefinitely is almost sure to contain putrefying vegetable or animal matter that gives off obnoxious odors.

Sewage Treatment in England

Progress made during 1922, as summarized by the president of the Association of Managers of Sewage Disposal Works. Special interest in activated sludge.

In his presidential address last December before the Association of Managers of Sewage Disposal Works (England), Joseph Garfield gave a brief summary of the progress made in sewage treatment during 1922. The following summarizes the principal points of his address:

Interest centered chiefly about the activated sludge system. At Bury it was demonstrated that for that particular sewage it is necessary to break up the surface of the sewage in the tanks that was in contact with the atmosphere and not merely bring the successive layers of sewage in contact with the atmosphere; and similarly at Bradford it was found that a propeller rapidly circulating the sewage in a tank did not provide sufficient air to support oxidation unless the surface were broken.

At Davyhulme, Manchester, it was demonstrated that, should a dose of matter deleterious to the process enter the tank, it is best to continue operation and wash out the interfering substance rather than attempt to deal with it by prolonged aeration.

Referring to the opinion of some that an excess of forms of animal life in an activated sludge tank are inimical to the process, the speaker said that this idea was not generally accepted, and that the lower organisms generally destroyed the higher ones without difficulty.

Concerning the value of activated sludge as a fertilizer, Mr. Garfield said that desire to use the nitrogenous value of this sludge has probably made the problem of sewage disposal more difficult than it was formerly. In old days it was thought sufficient if the sludge could be rendered into a condition suitable for transport and thereby disposed of in some out-of-the-way place. Now we have to deal with a sludge which has great value on paper and the question arises: Will the dewatering of the sludge in this particular form be worth while? The markets of the world for this material theoretically are unlimited, but the actual markets from time to time are erratic. During the past year there has been a considerable demand for nitrogenous fertilizers containing not less than 4% of nitrogen. The price offered for this material in a dry, powdered form, packed in bags, had been $14 per ton at the producer's works. This material is wanted for export in regular large quantities, but will the market even

at this price continue? Again, one has to look not only at the local markets, but the markets of the world, when contemplating the huge production of a commodity which has not been available before. The city of Bradford for twenty years has put on the market large quantities of a fertilizer and grease produced from sewage sludge. The fertilizer was of a low grade but in a condition suitable to application to land. The chief markets in pre-war days were in France and Germany. The cost of transport, however, has so increased as to kill these markets.

"The recovery of successively increasing quantities of grease has thrown a large quantity of material on the market, which in times of bad trade it is not possible to dispose of. But the sewage of a city has to be disposed of irrespective of the markets, and it might be found that the activated sludge process would not be ruled out of court even if some process of further fermentation of the sludge had to be used, whereby a great deal of the manurial value was lost, but which resulted in the production of a smaller quantity of innocuous residue which could be more easily disposed of."

Mr. Garfield then described at some length an experiment carried out at Bradford as a substitute for chemical precipitation as a preliminary process. The Bradford sewage is exceptionally strong and would require considerable chemicals to secure coagulation. The experiment was made in a circular tank 14 feet diameter and 35 feet deep holding 30,000 gallons, 20,000 gallons per 24 hours being treated. Fresh sewage was run in at the surface of the tank and flowed out at a point 24 feet below the surface. It was aerated by compressed air delivered at the bottom of the tank through a ½-inch pipe with open end, and after prolonged aeration it was found that coagulation took place and sludge was precipitated in the same way as though a heavy dose of chemicals were used. The tank was operated as a continuous-flow tank and no suspended matter was allowed to accumulate in it. The effluent then passed through a sedimentation tank, the effluent from which was much clearer than obtained by chemical precipitation and in addition contained considerable dissolved oxygen and did not putrefy on standing. Chemical examination showed that the sludge in the sedimentation tank consisted of particles of suspended matter surrounded by particles of gas so small that it would require more than 20,000,000 to cover one square inch of surface. A noticeable feature of the action of this tank is the destruction of fats. The crude sewage contained 3½ tons of ether soluble fat per million gallons, while the effluent contained only a trace of fats, and in the sludge they amounted to only a half of those found in the crude sewage. The nitrogen content of the sludge is about 3%.

Municipal Lighting of Los Angeles

The City of Los Angeles recently purchased from the Southern California Edison Company for $11,000,000 the plant and equipment used in supplying electrical energy within the city limits. The city has installed several "super white ways" on various streets and is now giving attention to improving the lighting in the outlying streets and those business streets that are not included in the ornamental lighting area.

These streets will be equipped with pendant units operating 20-ampere series Mazda lamps suspended at street intersections. The pendants are of the Westinghouse Dustproof type, having two compartments, an upper ventilated compartment containing the auto transformer and a lower closed compartment containing a lamp. They will be equipped with the new Westinghouse bowl refractor of the closed type, seated on a felt gasket, thus entirely shutting out bugs and dirt from the lamp chamber.

Holophane refractors will be used, a type having been selected which will illuminate the area adjacent to the pendants as well as between them. This refractor consists of two pieces of pressed crystal glass nested one within the other and clamped together so as to form a single unit. The inside surface of the inner piece and the outside surface of the outer piece are smooth, so that the assembled unit can be cleaned easily. The outer surface of the inner piece is so provided with prisms as to bend downward the upward rays of light and also spread part of the downward rays; while the inner surface of the outer piece is fluted so as to reduce the brilliancy. This refractor greatly increases the light emitted at angles between 60 degrees to 85 degrees with the vertical.

Street Cleaning in Toledo

Details of methods and costs; also of garbage collection and sewage pumping.

In his report for the year ending Dec. 31st, 1922, S. A. Foster, commissioner of streets of Toledo, Ohio, gives some interesting figures and facts concerning the year's work. In his letter of transmission he says: "We have made every effort to carry out the promises and wishes of this administration to run the department on a business basis and carry no one on the payroll who was not efficient and willing to work full eight hours per day, thus cutting the old force approximately in half and accomplishing better results."

The streets were cleaned by machine, by hand patrol and by flushing, in addition to which the department removed the snow and cleaned catch basins.

All of the streets scheduled for machine cleaning received from 10 to 40 cleanings annually. Four sweeping crews were maintained and removed 26,437 loads of dirt and rubbish.

Hand patrol cleaning was used in the business district and in residential sections where it was requested. A daily average of 30 men and 3 teams were employed in this service.

Four crews were employed in flushing on both day and night shifts. Owing to the heavy traffic in the business section during the day, the streets here are flushed every night except Sundays during the Summer months. Approximately 14,000,000 gallons of water was used in flushing the streets.

During the year 7,241 loads of snow were removed from the streets in the central part of the city. Seven men and two single rigs were employed in catch-basin cleaning and 3,500 basins were cleaned during the summer months. Alleys also were cleaned by the department and 15,811 loads of ashes and rubbish removed from them.

The general cleaning cost $183,151, of which $20,290 was for men working at the city dumps. In addition, there were spent $24,687 for special street-cleaning, $5,684 for supervision, $1,999 for clerk hire, $33,992 for labor in shop and yard, $1,544 for miscellaneous and $828 for new equipment; giving a total expenditure of $251,855 for street-cleaning. In addition there was spent for street repair $147,146, of which $136,848 was for labor and $2,774 for new equipment. Garbage was collected at a cost of $122,043 and disposed of at a cost of $12,977. Sewers were maintained at a cost of $17,023 and an additional $3,045 was spent for labor and supplies at the sewer pumping station.

Most of the catch basins were cleaned by bucket and windlass, but 123 cleanings were by spoon shovels. 2,477 loads of dirt were removed from the 2,968 cleanings, or almost a load of dirt for each cleaning.

The sewage pumping station was opened early in November with four operators and three assistant operators and three laborers. Actual pumping of sewage began on Dec. 7th, on which date performance tests were started by Fuller & McClintock, the engineers, and by the contractor, A. Bentley & Sons Company. The pumping equipment consists of five motor-driven single-stage centrifugal pumps, four with a capacity of 36,000,000 gallons each per 24-hours and one of 24,000,000 gallons capacity. Space is provided for an additional pumping unit. At the end of the year the pumps had been operated a total of 91 hours and 41 minutes and pumped approximately 116,376,000 gallons of sewage, using 9,856 k.w.h. of current.

The garbage is collected by city-owned teams and trucks and part is delivered to the Pan-American Feed Milling Company and the remainder hauled to farms and plowed under. Twenty-nine teams and wagons, six 1-ton Ford dump trucks, two Ford roadsters and an average of 60 men, including drivers and helpers, with three foremen perform this work. The total amount of garbage collected was 14,966 loads estimated to weigh 25,495 tons.

A foreman and ten men are employed at the stables to take care of 100 horses and mules. A horseshoer and assistant shoe all the horses and mules used by this and the other municipal departments. One floor man, two blacksmith helpers and a wagonmaker do all the rebuilding and repairing on wagons, street sprinklers, flushers and white-wing carts and make the necessary repairs on trucks, and autos, and repair tools and implements used by the departments. Two carpenters do all the carpenter repairing for the departments besides work for other departments when necessary. One painter paints all the buggies, automobiles, etc., for this and the other departments.

The total expenditures for all of these services, together with the operation of a comfort station, was $718,065. During the year 1921 the expenditure was $1,173,000.

Pressed Steel Water Tanks

Water tanks abroad as well as in the United States have generally been constructed circular in form and composed of either steel plates riveted together or of reinforced concrete—the latter greatly in the minority, with wood staves for the smaller sizes. An English firm has introduced a type of tank made of pressed steel plates to be erected into rectangular tanks, the chief claim of which is that it does not require specially trained riveters or other skilled men and that transportation is easy into mountainous regions or other districts where transportation facilities are primitive. The individual plates are about one-third the weight of castiron plates used for the same purpose and are unbreakable.

The plates are in standard units 4 feet square and 5/16 or 1/4-inch thick, with flanges 3 inches wide and bolt holes 5/8-inch in diameter. Each plate is stiffened with ribs pressed into its outer surface. Any number of these plates can be bolted together so as to give various dimensions in multiples of 4 feet, both horizontally and vertically. For the corners, plates are used flanged on two adjacent sides and bevelled on the other two, the bevelled edges coming at the vertical and horizontal corner joints. The joints are made with strip of lead 2¾ inches by 1/8-inch thick laid between the flanges before they are bolted up and caulked tight from the inside of the tank. Stays are provided inside the tanks made of 2 1/2 x 2 1/2 x 5/16-inch angle bars, short stays being connected from the bottom to the first flanged joint and long stays to the upper tiers of plates.

The tanks are supported on towers of steel construction, one tank erected in India being 28 feet square and 12 feet deep and supported on nine vertical columns 26 feet high, these columns being capped with steel beams to support the flat bottom of the tank. Other towers have been erected at Sunderland, Birmingham and other cities of England.

Traffic Stripes on Roads

Nevada is painting a black center stripe on all its concrete pavements with a view to keeping traffic to the right and thus reduce the number of collisions. Last fall a small spraying machine was obtained for painting the stripe mechanically much more rapidly and cheaply than it can be done by hand. The machine is mounted on a truck which permits very rapid work.

Similar work is done in Michigan and to reduce the cost, Wayne County has developed a machine consisting of a DeVillibio compressed air painting machine mounted on a Ford truck. A wooden wheel about 2 feet in diameter and 4 inches wide and covered with a strip of felt about 1 inch thick revolves on an axle which is part of an iron frame attached to the rear of the truck in such a position that it follows in the track of the left-hand wheels of the truck. A spray of paint is applied directly

to the felt about 1 foot above the pavement and is immediately transferred to the pavement by the wheel. Although the pavement is concrete, white paint is used because much of the old concrete has been darkened by oil drippings, making a black line difficult to follow at night.

Before the painting machine is driven over the road, the center of the road is marked with chalk at intervals of 50 feet to guide the driver. In repainting an old line, the driver merely keeps his left-hand wheels on the old paint line. While hand painting required four painters to paint a mile of road a day, with the painting truck two men cover 6 to 7 miles a day.

Wisconsin Highway Notes

The Wisconsin Legislature on March 15th made immediately available the sum of $1,500,000 to meet federal aid in the same amount, thus placing in the highway construction fund the sum of $3,000,000. This bill provides merely for preliminary and immediate financing.

There is a surplus of $711,000 left over from last year's automobile license fees which, under the law governing maintenance, could not be spent this year for maintenance purposes. The Senate unanimously and the Assembly with only two votes against it passed a bill permitting this fund to be used to meet federal aid. The balance of the $1,500,000 above referred to is provided for by taking $789,000 from this year's license fund.

The bill decided upon by the joint highway committee for financing highway work for 1924-1925 arranges for raising $8,000,000 for state road construction and maintenance by a license tax on motor vehicles based on weight, beginning at $10 for a Ford car. It also provides for raising $3,000,000 by a 2c. tax on gasoline, this $3,000,000 to be distributed among the counties on the basis of the rural highway mileage of the counties, the amount received to be spent on such roads as the county boards may determine.

Highway Work in Louisiana

The Highway Commission of Louisiana spent more than $4,000,000 in 1922, included in this being parish funds and Federal aid. About 90 per cent. of the highways constructed last year were surfaced with gravel and the remainder with shell, Uvalde rock asphalt and bitulithic.

Soil carrying large amounts of iron is found in the northwestern part of the State which has been used as a binder instead of clay and is believed to be superior to it. By using this local material the roads have been built at a saving of from $2,000 to $3,000 a mile. Material said to contain 75 per cent. metal is being used on some of the highways as a base course. The city pays about 10c. a yard royalty for this material as against $1.00 a yard for freight on sand-clay and gravel.

It is stated that by the end of 1923 six cross-state highways will be nearing completion.

Highway Statistics

Compiled from information furnished to Public Works by the officials of more than three hundred counties and states, showing the sums spent in 1922 and available for 1923, the amounts and costs of each type of pavement laid, and certain details concerning use of reinforcement and methods of resurfacing old pavements.

Federal aid will be furnished to the amount of more than sixty-three million dollars during the fiscal year beginning June 30. To obtain this the states must appropriate an equal amount; except that ten of them, because of sparse settlement, need furnish only from 47 to 12.77 per cent of the total cost. On the other hand, many of the eastern states will spend several times the F. A. allotment. It therefore seems probable that considerably more than $150,000,000 will be spent on highway construction this year; and maintenance should run into even higher figures.

Taking the three hundred counties in the following tables, which are spread all over the country, as typical of the entire country, the expenditure this year will be almost exactly the same as last. The figures given us from these counties show about $70,000,000 spent by them last year and an estimate of $80,000,000 for 1923; but past experience would indicate that construction will probably fall somewhat short of the program.

Under the seven per cent provision of the Federal Aid law, 197,412 miles may receive federal aid, the total mileage of the country as certified by the several states being 2,820,165, Texas leading the states with a total of 182,816 miles. Of the total, more than two and a half million miles are only dirt roads.

These figures give some idea of the highway situation. Details on several points are furnished in the following tables, which have been compiled from information furnished to us by more than three hundred highway officials. These give the amount and cost of each kind of improvement done in each of the counties last year, and the amount contemplated for 1923; also the total expenditures of 1922 and the amount available for 1923. In addition, state officials have informed us as to the amounts spent by their several states last year, the amount that will probably be spent this year, how the state will raise its funds, and the kind and amount of work they expect to do.

(*Continued on page* 144)

COUNTY EXPENDITURES FOR HIGHWAYS

County and State	Total County, State and Federal Funds: Spent in 1922	Total County, State and Federal Funds: Available for 1923
Arizona:		
Coconino	$110,478	$100,000
Graham	200,000	500,000
Maricopa	5,000,000	2,000,000
Navajo	215,000	44,000
Pinal	84,448	75,000
Yuma	165,000	.....
Arkansas:		
Polk	200,000	50,000
Colorado:		
Clear Creek	28,883	125,000
Costilla	50,000	.....
Delta	190,000	145,200
Elbert	121,000	125,000
Logan	249,000	321,000
Mesa	277,135	194,900
Rio Blanco	51,562	67,000
Rio Grande	70,000	59,000
Sedgwick	94,000	59,000
Connecticut (Towns):		
Darien	116,270	60,000
Lynn	none	26,000
New London	32,000	.....
Warren	3,500	3,500
Windsor	17,000	20,000
Delaware:		
New Castle	730,225[a]	500,000[a]
Illinois:		
Cass	250,000	350,000
Christian	347,000[a]	417,000[b]
DeWitt	38,000	30,000
Fulton	437,000	520,000
Greene	292,000	137,000
Hancock	.....	30,000[a]
Jasper	140,000	.....
Kane	700,000	1,000,000
Macoupin	41,000	89,000
Mason	20,000[c]	54,000
Massac	70,000	93,000
Monroe	20,000	20,000
Peoria	500,000	1,139,500
Pulaski	40,000	45,000
Randolph	5,000	30,000
Richland	.....	13,000[d]
Sangamon	1,345,000	.....
Stark	1,000	185,000
Stephenson	350,000	670,000
Whiteside	35,000[a]	80,000[a]
Will	64,786[a]	60,000[a]
Williamson	285,550	630,000
Winnebago	745,134	670,745
Woodford	53,163[a]	40,000[a]
Indiana:		
Henry	638,000	80,000[a]
Jasper	265,000	235,000
Jennings	157,678	125,000
Madison	600,000	.....
Shelby	140,042	.....
Vigo	929,490	5,500,000
Iowa:		
Adams	166,145	55,000
Appanoose	220,000	210,000
Audubon	300,000	40,000
Benton	125,000	115,000
Boone	179,797	150,000
Bremer	182,000	200,000
Buchanan	537,000	120,000
Buena Vista	98,600	120,000
Cerro Gordo	159,990	182,000
Chickasaw	232,000	75,000
Clay	200,000	200,000
Clayton	300,000	100,000
Crawford	150,000	250,000
Dallas	453,096	.....
Decatur	174,000	164,000
Des Moines	58,200	.....
Dickinson	77,238	115,450
Emmet	47,061	90,686
Floyd	.....	70,000
Greene	100,000	140,000
Grundy	130,000	130,000
Guthrie	300,000	150,000
Hancock	480,000	110,000
Hamilton	300,000	170,000
Harrison	40,000	350,000
Howard	60,000	60,000
Jackson	90,000	175,000
Jefferson	75,529	135,304
Jones	180,000	200,000
Kossuth	850,000	90,000
Lucas	85,000	40,000
Lyon	24,560[a]	66,000[a]
Marion	152,499	295,000
Mitchell	198,000	114,000
Muscatine	187,000	136,000
Osceola	80,000	15,000
Pocahontas	143,133	120,000
Pottawattamie	600,000	100,000
Poweshiek	203,000	.....
Iowa (Continued)		
Sac	230,000	250,000
Shelby	80,000	63,000
Tama	250,000	.....
Union	100,000	150,000
Van Buren	90,000	200,000
Wapello	120,000	115,000
Webster	215,000	150,000
Woodbury	650,000	1,159,000
Worth	40,000	60,000
Kansas:		
Allen	389,597	.....
Barber	24,801[a]	25,000
Barton	90,000	64,000
Bourbon	361,657	280,000
Brown	150,000	150,000
Butler	145,497	725,000
Cloud	.....	40,000
Cowley	87,300	70,000
Crawford	929,085	250,000
Ellis	19,550	44,390
Geary	130,698	44,000
Graham	38,000	25,000
Gray	39,472	63,470
Harvey	33,500	34,300
Hodgeman	35,537	31,000
Jackson	77,000	110,000
Kingman	75,000	70,000
Labette	50,000	300,000
Lincoln	35,000	45,000
Lyon	240,000	600,000
Osage	79,859	62,500
McPherson	18,098	.....
Ottawa	152,000	77,000
Rawlins	.....	50,000
Reno	1,000,000	350,000
Republic	67,252	103,000
Sedgwick	1,000,000	600,000
Thomas	16,700	42,000
Wabaunsee	75,000	30,000
Kentucky:		
Allen	28,000	25,000
Boyle	45,000	109,000
Clark	450,000	300,000
Crittenden	24,000	32,000
Fleming	39,100	37,000
Gallatin	11,368	17,000
Jefferson	325,000	650,000
Oldham	30,000	.....
Owen	15,000[a]	200,000[a]
Rockcastle	95,000	90,000
Woodford	75,000	50,000
Louisiana (Parishes):		
Beauregard	64,000	223,000
Caddo	665,000	700,000
Claiborne	.....	150[a]
East Carroll	25,000	None
Lafourche	110,000	225,000
Lincoln	275,000	750,000
Ouachita	167,000	500,000
Rapides	.....	400,000
St. Landry	653,460	600,000
Michigan:		
Branch	200,000	150,000
Cass	210,000	500,000
Charlevoix	150,000	170,000
Chippewa	291,815	200,000
Delta	300,073	242,000
Eaton	402,000	321,000
Emmet	318,000	.....
Hillsdale	135,610	440,000
Kalamazoo	1,000,000	700,000
Kent	1,200,000	.....
Keweenaw	132,429	176,000
Lake	100,000	50,000
Luce	77,000	113,000
Macomb	750,000	700,000
Muskegon	850,000	699,000
Ottawa	397,000	.....
St. Joseph	74,808	217,000
Van Buren	162,348	127,546[a]
Minnesota:		
Aitkin	.....	27,800[a]
Beltrami	224,162	89,562
Benton	78,364[f]	60,000[f]
Big Stone	58,161	50,000
Blue Earth	198,017	160,000
Brown	91,890	80,000
Carlton	90,479	100,000
Carver	146,000[g]	137,000
Chisago	110,000	90,000
Clay	104,219	120,000
Cottonwood	90,000	140,000
Dakota	327,890	235,000
Dodge	168,501	232,000
Freeborn	317,741[g]	173,000
Goodhue	293,022	185,000
Grant	67,117	65,000
Houston	85,000[h]	50,000[h]

COUNTY EXPENDITURES FOR HIGHWAYS—Continued

County and State	Total County, State and Federal Funds: Spent In 1922	Total County, State and Federal Funds: Available for 1923
Minnesota (Continued)		
Hubbard	58,107	20,000
Isanti	145,000	75,000
Jackson	253,000	300,000
Kandiyohi	200,000	110,000
Lake of the Woods[l]	34,528	20,000
Lincoln	109,008	211,955
Lyon	144,029[c]	210,000
McLeod	.....	97,000
Mahnomen	34,092	15,860
Martin	159,300[a]	175,000
Meeker	250,000	150,000
Mille Lacs	30,200	40,000
Murray	150,000	67,000
Nobles	252,125	287,503
Norman	60,000	60,000
Otter Tail	360,000[c]	150,000
Pine	108,957	92,000
Polk	225,000	300,000
Rice	142,790	1,000,000
Rock	88,971	99,000
Sherburne	110,575	100,000
Sibley	136,000	123,000
Stearns	110,000	100,000
Steele	111,672[a]	110,000
Stevens	33,148	41,667[d]
Swift	70,742	190,000
Wadena	67,000	70,000
Washington	122,356	105,000
Watonwan	65,000	120,000
Wilkin	54,315	110,000
Wright	183,097	125,000
Montana:		
Cascade	265,000	370,000
Chouteau	25,000	20,000
Gallatin	501,391	120,000[m]
Granite	73,000	73,000
Hill	125,000	30,000
Madison	82,565	60,000
Missoula	56,387[a]	40,322[a]
Toole	50,000	5,000
Nevada:		
Esmeralda	2,000[a]	.....
North Dakota:		
Cass	105,000	300,000
Eddy	.....	25,000
Grant	75,000	70,000[b]
Hettinger	14,000	.....
McLean	72,914	35,000
Ramsey	75,000	73,000
Traill	15,000	40,000
Williams	91,659	70,000[a]
Ohio:		
Allen	.....	350,000
Ashtabula	1,377,500	800,000
Carroll	519,641	175,000
Clark	160,500[b]	156,650
Clinton	310,953	27,500
Fairfield	250,000	600,000
Hancock	435,000	.....
Harrison	220,000	300,000
Henry	286,000	210,000
Holmes	271,700	275,000
Lucas	653,902	800,000
Madison	108,335	140,000
Marion	577,780	.....
Medina	264,644	362,359
Ottawa	47,213	188,000
Paulding	167,000	110,000
Putnam	335,000	300,000
Richland	450,000	1,650,000
Ross	200,000	.....
Sandusky	500,000	150,000
Trumbull	980,000	637,000
Van Wert	250,000	225,000
Warren	300,000	180,000
Oklahoma:		
Beaver	89,000	None
Blaine	53,957	52,200
Creek	267,400	.....
Garfield	300,000	50,000[n]
Grady	68,000	60,000
Jackson	90,763	39,520[n]
McIntosh	10,000	26,000
Texas	110,492	105,000
Tillman	101,000	233,000
South Carolina:		
Abbeville	200,000	175,000
Anderson	171,000	50,000
Greenwood	57,443	70,000
South Dakota:		
Butte	50,000[a]	85,000[a]
Deuel	16,290	115,000
Grant	50,075	.....
Hanson	43,785	50,000
Jackson	61,000[p]	59,000[p]

County and State	Total County, State and Federal Funds: Spent In 1922	Total County, State and Federal Funds: Available for 1923
South Dakota (Continued)		
Kingsbury	73,000[a]	107,447
Mellette	6,000	14,000
Potter	18,000	40,000
Spink	175,000	110,000[a]
Sully	34,915	30,000
Tripp	150,000	100,000
Tennessee:		
Clay	16,000	40,000
Franklin	40,000	20,000
Grundy	.....	190,000
Hancock	12,000	130,000
Johnson	20,000	18,000
Texas:		
Bowie	315,000	230,000
Brooks	4,850	129,000
Cameron	75,000	750,000
Coleman	250,000	1,306,500
Colorado	40,000	60,000
El Paso	504,896	165,000
Fannin	21,000	500,000
Fayette	195,000	400,000
Gillespie	60,000	60,000
Guadalupe	50,000	165,000
Harris	355,000	550,000
Hidalgo	368,000	2,250,000
Karnes	150,000	.....
Kaufman	.....	140,000
Palo Pinto	100,000	1,500,000
Red River	31,000	300,000
Rockwall	180,000	300,000
Runnels	30,000	40,000
Schleicher	170,000	124,000
Shelby	50,000	377,000
Smith	450,000	600,000
Tom Green	200,000	300,000
Uvalde	None	600,000
Wise	22,000	191,000
Virginia:		
Albemarle	485,000	600,000
Augusta	42,200	136,000
Pittsylvania	100,000	460,000
Tazewell	210,000	325,000[a]
Washington:		
Clarke	600,000	500,000
Ferry	50,000	210,000
Gray's Harbor	915,317	583,391
Jefferson	95,000	80,000
Lewis	244,384[a]	280,000[a]
Lincoln	288,000	377,000
Okanogan	125,000	150,000
Pend Orellle	158,000	196,000[e]
Pierce	240,617	463,275
Skagit	205,969	250,000
Wahkiakum	153,600	34,360[a]
Whatcom	321,100[b]	.....
Whitman	315,000	500,000
West Virginia:		
Berkeley	150,000	100,000
Boone	225,000	164,000
Mineral	180,000	200,000
Taylor	156,450	.....
Upshur	105,000	390,000
Wood	260,961	700,000
Wisconsin:		
Adam	48,286	24,000
Ashland	120,000	175,000
Bayfield	126,541	97,208
Florence	65,628	ap.57,000
Fond du Lac	1,134,046	1,500,000
Forest	125,000	125,000
Iowa	22,500	None
Jackson	125,146	105,757
Jefferson	.....	1,300,000
Juneau	115,519	ap.120,000
La Crosse	540,000[a]	500,000
Polk	165,000	188,000
Richland	160,634	324,687
Sauk	125,000	300,000
Sawyer	120,000	148,000
Shawano	284,514	275,500
Sheboygan	413,733	320,936
Vernon	350,000[f]	286,000
Walworth	795,400	978,318
Waushara	91,000	64,000

[a]County funds only; [b]county and township funds; [c]on bridges; [d]State aid; [e]State only; [f]county and State aid; [g]does not include money spent by State on trunk roads; [h]does not include Federal aid; [i]new county—included under Beltrami Co. in 1922; [m]$124,000 additional for Federal Forest Service in this county; [n]until July 1, when new appropriations will be made; [p]township included; [r]also some Forest Service work; [s]does not include State funds.

ROAD IMPROVEMENT DONE IN 1922

County	Grading		Earth Surfacing		Gravel		Culverts and bridges included in cost
	Amount Miles or sq. yds.	Cost	Amount Miles or sq. yds.	Cost	Amount Miles or sq. yds.	Cost	
Arizona:							
Navajo	54	$750[m]	.....	.....	54	$2,500[m]	No
Pinal	3	4,272	31	$70,950	.....	.....	No
Yuma	42	31,500	.....	.....	17	68,500[g]	10 Corr. pipe culv.
Arkansas:							
Polk	.....	.....	.....	.....	15	10,000[gm]	25 bridges
Colorado:							
Costilla	18	30,000	5	5,000[g]	.....	.....	Yes
Delta	17	5,100[m]	.....	.....	20	83,000[gm]	4,778 ft. corr. pipe and 266 ft. concr. culv.
Logan	.....	.....	.....	.....	84	50,400[g]	4 bridges, 80 culv.
Mesa	7.5	18,000	.....	.....	7.1	100,000[g]	7 bridges and culv.
Rio Grande	63	.....	5	.....	4½	.....	4 steel and 1 concr. bridges
Sedgwick	.....	53,000	.....	.....	19.25	41,000[g]	7 bridges, 1 carload of culv.
Connecticut (Towns)							
Warren	.....	.....	.....	.....	.....	200	.....
Windsor	80	5,000	.....	.....	1	1,000[g]	.....
Delaware:							
New Castle	.....	113,401	.....	.....	.....	.....	.....
Illinois:							
Cass	100	30,000	125[h]	20,000	.....	.....	No
Christian	30	35,000	250[h]	150,000	.....	.....	No
De Witt	10	2,500[m]	100[h]	30,000[m]	.....	.....	No
Fulton	9	293,000	500	100,000[g]	.....	.....	Yes
Greene	15	80,000[d]	.....	.....	.....	.....	.....
Macoupin	505	60[m]	.....	.....	.....	.....	.....
Massac	.....	.....	.....	.....	10	20,000[g]	.....
Monroe	60	.....	.....	.....	.....	.....	Yes
Peoria	3	30,000	110	330,000[g]	.....	.....	160 culverts
Pulaski	5	2,000[m]	.....	.....	3	3,000[gm]	.....
Randolph	1.5	5,000	.....	.....	.....	.....	No
Sangamon	97	.....	62	9,000[g]	.....	.....	Yes
White	14	.....	.....	.....	15	75,000	Culverts
Williamson	.....	.....	.....	.....	2	40,000[g]	Av. $2,500 per mile
Woodford	13.75	16,827	28	1,334	.....	.....	.....
Indiana:							
Jennings	.....	.....	.....	.....	5	24,284[g]	$12,000 total
Madison	.....	.....	.....	.....	11.5	36,235[g]	50 pipe culverts
Shelby	.....	.....	.....	.....	12.3	4,100[gm]	Yes
Vigo	.....	.....	.....	.....	25.1	100,240[g]	30 culv. and bridges
Iowa:							
Adams	7	43,714	.....	.....	.....	.....	.....
Appanoose	200,000 cu. yds.	29¼ cts.	85	98[m]	.....	.....	.....
Audubon	17.5	300,000	.....	.....	.....	.....	Culverts
Benton	35	50,000	.....	.....	.....	.....	No
Boone	.....	.....	.....	.....	.....	18,200	.....
Bremer	13	82,000	.....	.....	7	28,000	45 culverts
Buchanan	6	23,000	.....	.....	.....	.....	.....
Buena Vista	1	5,000	.....	.....	9	12,000	No
Cerro Gordo	0.5	1,250[m]	.....	.....	20	1,650[m]	No
Chickasaw	24	.....	.....	.....	10	.....	42
Clay	7	30,000	.....	.....	40	57,000	No
Clayton	50	150,000	.....	.....	26	100,000	No
Crawford	15	120,000	.....	.....	.....	.....	.....
Dallas	58	1,786[m]	.....	.....	52	1,822[m]	No
Decatur	36.7	4,891[m]	.....	.....	.....	.....	.....
Dickinson	.....	.....	.....	.....	38	22,352	No
Emmet	.....	.....	21.75	4,268	26.5	18,226	20 culverts
Greene	.....	.....	.....	.....	20,000	19,000[g]	42 culv. and 1 bridge
Grundy	10	60,000	.....	.....	14	40,000	No
Guthrie	250,000 cu. yds.	30 cts.	.....	.....	.....	.....	.....
Hancock	24	50,000	.....	.....	14	15,000	No
Hamilton	100,000 cu. yds.	30 cts.	.....	.....	18,000 cu. yds.	2.00	No
Harrison	3	25,000	50	10,000	.....	.....	No
Howard	10.5	25,000	.....	.....	11	35,000	No
Jackson	.....	48,300	1,100 cu. yds.	600	.....	.....	No
Jefferson	90,000 cu. yds.	27 cts.	.....	.....	.....	.....	.....
Jones	24	140,000	.....	.....	5	10,000	No
Kossuth	17	140,000	.....	.....	150	300,000[g]	.....
Lucas	6	45,000	.....	.....	.....	.....	26 culv. and 1 bridge
Lyon	28	24 cts.[r]	.....	.....	12	1,500[m]	.....
Marion	.....	.....	300	30,000	.....	.....	No
Mitchell	7	200,000	.....	.....	9	22,000	No
Muscatine	28.4	22¼ cts.[r]	.....	.....	7	.....	.....
Osceola	13	25,000	.....	.....	17	34,000	No
Pocahontas	.....	.....	.....	.....	15	35,000	.....
Pottawattamie	50	.....	.....	.....	.....	.....	.....
Sac	31	2,400[m]	.....	.....	.....	.....	.....
Shelby	5	25.5[r]	.....	.....	.....	.....	.....
Tama	30	170,000	.....	.....	2.5	7,500	.....
Union	97	8,500	154.5	35,000[g]	.....	.....	34 culverts
Van Buren	50	10,000	.....	.....	.....	.....	80 bridges
Wapello	10	46,000	.....	.....	.....	.....	No
Woodbury	20	.....	.....	.....	.....	.....	.....
Worth	8	34,000	.....	.....	3	6,000	.....
Kansas:							
Allen	26	30,832	139	5,668	.....	.....	No
Barber	19	485[m]	.....	.....	.....	.....	Yes
Barton	3,000	50 cts.	.....	.....	.....	.....	No
Butler	2.5	2,000[m]	240	200[m]	.....	.....	No
Cowley	150	75[m]	.....	.....	7,920	7,920	No
Crawford	21	3,500[m]	.....	.....	.....	.....	No
Ellis	100	5,062	.....	.....	.....	.....	.....
Geary	88.5	143.[m]	88.5	44,86[m]	.....	.....	No
Graham	88	27,000	14	11,000	.....	.....	No
Gray	128	72.80[m]	.....	.....	.....	.....	No
	360	35.00[m]	.....	.....	.....	.....	No
Harvey	60	000	6	10,500	.....	.....	No

For foot notes see page 141.

ROAD IMPROVEMENT DONE IN 1922—(Continued)

County	Grading		Earth Surfacing		Gravel		Culverts and bridges included in cost
	Miles or sq. yds.	Cost	Miles or sq. yds.	Cost	Miles or sq. yds.	Cost	
Kansas (Continued)							
Hodgeman	32	$5,223	.....	.....	.....	.....	No
Jackson	49	19,870	.....	.....	.....	.....	No
Kingman	100	6,000	.....	.....	.....	.....	No
Labette	2.25	6,000[e]	.....	.....	10	$40,000	Culverts
Lyon	100	30,000	.....	.....	.....	.....	No
McPherson	.....	.....	.....	.....	3	.....	No
Osage	.....	.....	207	$44,740[g]	.....	.....	.....
Ottawa	.....	.....	80	42[m]	.....	.....	No
Peno	100	100[m]	.....	.....	.....	.....	.....
Republic	55,000	15,850	.....	.....	.....	.....	No
Riley	.....	10,000	.....	.....	.....	.....	.....
Thomas	81.5	43.55[m]	.....	.....	.....	.....	.....
Wabaunsee	80	5,000	.....	.....	2	4,000[e]	No
Kentucky:							
Allen	15	1,000[m]	.....	.....	6	2,000[gm]	Yes
Crittenden	8.5	2,800[m]	.....	.....	.....	.....	Yes
Jefferson	.....	.....	.....	.....	4	6,000[g]	.....
Rockcastle	.....	.....	55	18,000	1	2,000	.....
Louisiana:							
Beauregard	312	42,000	326	15,000[g]	62	.....	84
Caddo	.....	.....	30	45,000	3	30,000	Few culverts
Claiborne	35	.....	.....	.....	35	.....	.....
East Carroll	30	25,000	.....	.....	.....	.....	No
Lafourche	150,000 cu. yds.	30,000	.....	.....	17,000 cu. yds.	51,000	No
Lincoln	27	2,000[m]	.....	.....	27	8,000[m]	3 bridges
Ouachita	.....	.....	.....	.....	10	120,000[g]	4 bridges, 30 culv.
St. Landry	.....	.....	.....	.....	71.8	9,100[gm]	Yes
Michigan:							
Branch	.....	.....	.....	.....	40	160,000[g]	Yes
Cass	24	50,000	.....	.....	11	75,000[g]	Yes
Charlevoix	182,000	35 cts.	.....	.....	100,000	45 cts.	.....
Chippewa	18	38 cts.[y]	.....	.....	5	.....	.....
Delta	5	5,000[m]	.....	.....	11	12,000[gm]	Yes
Eaton	26,386 cu. yds.	11,419	.....	.....	30,244	14,119	No
Emmet	.....	.....	.....	.....	28.5	231,340[g]	Many culverts
Kalamazoo	.....	.....	.....	.....	45	8,000[gm]	Culverts and 1 bridge
Kent	.....	.....	.....	.....	7.5	8,800[gm]	32
Keweenaw	7.5	.....	.....	.....	3	.....	.....
Luce	4	22,000	.....	.....	3	20,000	300 ft. corr. culv.
Macomb	.....	.....	.....	.....	11	.....	.....
Muskegon	.....	.....	.....	.....	8.5	8,000[gm]	Aver. $15 per mile
Ottawa	6	3,200[m]	.....	.....	0.5	.....	130 culverts
St. Joseph	.....	.....	.....	.....	16	54,808[g]	Yes
Minnesota:							
Aitkin	9	62,000	.....	.....	10	16,000	.....
Beltrami	100.2	197,462	.....	.....	21.9	26,700	70 culverts
Benton	16	.....	.....	.....	15	16,900	No
Big Stone	10.9	21,769	.....	.....	16.9	22,000	No
Blue Earth	45.2	79,856	.....	.....	44.2	78,025	130-ft. bridge
Brown	52	57,300	.....	.....	38	34,590	Small culverts
Carlton	62.7	1,230[m]	.....	.....	20.9	1,090[m]	4 bridges, corr. culv.
Carver (Co.)	19	76,000	.....	.....	24	30,000	Yes
Carver (State)	4	22,248	.....	.....	.....	.....	27 culverts
Chicago	.....	.....	.....	.....	7	32,000	No
Clay	50	50,000	.....	.....	15	30,000	Yes
Cottonwood	9	2,500[m]	.....	.....	28	1,500[m]	No
Dakota	25	4,450[m]	.....	.....	15	1,370[m]	30
Dodge	21.5	104,520	.....	.....	15.25	21,144	4 bridges, 20 concr. culv., 5,580 ft. pipe
Freeborn	53	135,754	.....	.....	19	20,035	10
Goodhue	42.3	135,940	.....	.....	54.7	92,777	21 concr. culv., 8,808 ft. corr. culv.
Grant	5	13,243	.....	.....	15	21,000	10 culverts
Houston	1.5	12,000	27	4,800	22	.....	No
Hubbard	6.7	6,000	.....	.....	21.5	1,500[m]	.....
Isanti	15	60,000	.....	.....	18	72,000	.....
Jackson	60	80,000	.....	.....	33	90,000	No
Kandiyohi	70	180,000	.....	.....	.....	.....	320 ft. concrete
Lake of the Woods	19,888	10,515	8,175	6,005[g]	12,776	16,612[g]	No
Lincoln	27	96,392	.....	.....	11	12,615	22 concrete
Lyon	27.2	2,724	.....	.....	26.5	1,358	5,812 ft. pipe, 3 concrete, 1 bridge
McLeod	11	28,268	.....	.....	15	21,334	1 bridge
Mahnomen	5	26,140	.....	.....	.....	.....	2 concr., many pipe
Martin	10	53,500	.....	.....	23	40,600	.....
Meeker	40	150,000	.....	.....	25	25,000	.....
Mille Lacs	8	22,000	.....	.....	7	8,200	No
Murray	26	1,000[m]	.....	.....	42	800[m]	.....
Nobles	30	68,440	.....	.....	36	62,733	Culverts
Norman	20	20,000	.....	.....	.....	16,000	No
Otter Tail	40	260,000	.....	.....	24	35,000	200 culverts
Pine	56.5	60,889	.....	.....	8.5	2,464	.....
Polk	80	181,000	.....	.....	.....	.....	19
Rice	337,360	99,693	.....	.....	34,880	43,098	No
Rock	.....	.....	.....	.....	25	38,866	No
Sherburne	16.1	42,934	.....	.....	13	17,592	Grading incl. 3 bridges, 1 concr. culv., 1,100 ft. pipe
Sibley	43	66,000	.....	.....	37	39,000	.....
Stearns	14	35,000	.....	.....	21	18,000[g]	Yes
Steele	29.5	62,000	.....	.....	22	26,000	No
Stevens	14.1	21,092	.....	.....	.....	.....	No
Swift	8	34,228	.....	.....	.....	4,000	No
Wadena	60	500	3	1,500	1	1,500	Yes
Washington	8	30,000	.....	.....	8	18,000	3 concr. culv.
Watonwan	8	19,000	.....	.....	28	46,000	No
Wilkin	7.4	13,458	.....	.....	7	24,787	2 concr. & 35 pipe culv.
Wright	35	68,825	.....	.....	26	27,160	.....

For foot notes see page 143.

ROAD IMPROVEMENT DONE IN 1922—(Continued)

County	Grading		Earth Surfacing		Gravel		Culverts and bridges included in cost
	Miles or sq. yds.	Cost	Miles or sq. yds.	Cost	Miles or sq. yds.	Cost	
Montana:							
Cascade		$40,000			14.7	$122,000[g]	Yes
Chouteau	2	200					No
Gallatin	19.8	25,435			26.5	176,425[g]	Grading, 45 culv.; gravel, 120 culv.
Hill	18				18		No
Granite		66,000		$2,000		3,000	No
Madison	40		4		15		
Missoula	18,000	32 cts.	16	97.40[m]	52,000 cu. yds.	1.35[y]	No
Toole	30	270[m]			6.5	100[m]	No
North Dakota:							
Cass	100	20,000					No
Eddy	25	10,000			4	45,000	
Grant	7,600	25 cts.	150	150[m]	1,000 cu. yds.	3.00[y]	No
Hettinger	150	9,000			3	5,000	
McLean	10	50,000					1 bridge, 200 corr. culv.
Ramsey	19	50,000	14.5	25,000			6,000 ft. corr. culv.
Williams	97	39,270	19.5	48,231	2.18	4,158	2 bridges, 8 concr. culv., 2,042 ft. pipe
Ohio:							
Carroll	144,838	55 cts.					
Clark	12,500 cu. yds.	6,875			208	71,500	No
Harrison	5	4,000	700	65,000			4
Holmes					9.85	109,900	Yes
Richland	13.5	64,000			2	16,000	Yes
Ross				12,000		11,300	No
Trumbull	1.25	5,000					Yes
Van Wert					1	3,707	4 bridges, 10 culv.
Warren					75	100,000	Yes
Oklahoma:							
Beaver	157.3	37.60[m]	28.3	30 cts.[y]			No
Blaine		8,885				625	6 culverts
Creek	15	5,000	10	2,500			
Garfield	60	35[m]					No
Grady			10	10,000			10
Jackson	104	25.50[m]			2	13,000[m]	2 box culv.
McIntoch		125[m]	90	100[m]			
Texas	40	4,000	20	1.50[s]	10	2.80[s]	No
Tillman	230	40[m]					22
South Carolina:							
Anderson					47.5	3,600[g]	8 bridges, 4 concr. culv.
South Dakota:							
Deuel			100	9,650	1.5	1,480	No
Grant		32,422				17,653	Yes
Hanson	112	26,842			6	7,200	
Jackson			129	21,000	5.6	15,000	No
Kingsbury	64	8,203			12	30,241	Yes
Mellette	36	6,000					No
Potter	27	18,000					Culv. & 1 bridge
Sully	18,530	43 cts.			2,089	92 cts.	
Tripp	30	140,000	10	10,000			8 concr. viaducts; 24 concr. culv.
Tennessee:							
Clay	10	10,000			1	500	No
Hancock	15	12,000					2 bridges
Johnson	20						
Texas:							
Bowie	14	22,000			16	293,000[g]	11 bridges, 13 concr. culv.
Cameron	75	20,000			1	5,000[g]	10
Coleman	50	75,000			6	15,000	
Colorado	60	5,000			4	6,000	No
Fannin	4.5	12,120					No
Fayette	80	8,000			32	187,000[g]	Yes
Gillespie					10	60,000[g]	15 culverts
Guadalupe					3.3	20,000[g]	No
Harris	10	20,000			10	23,000	
Hidalgo					4.3		
Karnes			40	1,500			No
Palo Pinto	20	40,000			7	14,000	
Red River						31,000	1 culvert
Runnels	75	300			10	2,500	14
Schleicher	12	30,000			2.25	3,600	19 culverts
Shelby	50,000	16 cts.	2,000	30 cts.			No
Smith	80	2,900[m]			60	3,000[m]	No
Wise	20,000	4,500					No
Virginia:							
Albemarle	61	128,000	20	30,000			Yes
Augusta					2	6,000[g]	5
Tazewell	16	65,000					No
Washington:							
Clarke	30	30,000			45	160,000	Yes
Ferry	6	75[m]			4	1,250[m]	
Grays Harbor					20	15,000	Culverts
Jefferson			2	14,000	5	35,000[g]	1090 ft. of culv.
Lincoln	26	78,000			26	81,000	No
Okanogan	12	300[m]			10	8,000[gm]	Yes
Pend Orellle			6	9,000	9	90,000[g]	3 bridges; 20 culv.
Pierce	22.15	142,464					
Skagit					1.3	5,640[g]	5
Wahkiakum	6				6		
Whatcom					28.7	190,900[g]	50
West Virginia:							
Berkeley	100	500[m]					No
Boone		225,000					4
Mineral	15	100,000					Aver. $3,000 per mile
Taylor	6	36,000					Yes
Upshur	16,000						
Wood	5.3	58,681		91,837[g]			Aver. 400 ft. apart

For foot notes see page 143.

ROAD IMPROVEMENT DONE IN 1922—(Continued)

County	Grading: Miles or sq. yds.	Grading: Cost	Earth Surfacing: Miles or sq. yds.	Earth Surfacing: Cost	Gravel: Miles or sq. yds.	Gravel: Cost	Culverts and bridges included in cost
Wisconsin:							
Adams	14	13,804	9.6	34,482	.....	.....	1 bridge, 6 culvs.
Florence	33,916 cu. yds.	40.5 cts.[y]	.....	.....	8,631 cu. yds.	1.87[y]	.....
Fond du Lac	18	69,979	.....	.....	18	84,000[g]	Yes, except 12 mi. of grading
Forest	14	45 cts.[y]	.....	.....	6	1.75[y]	6
Jackson	93.75	20,222	6	1,800	8	6,500	No
Juneau	3	10,155	9	36,954[g]	2	23,000[g]	6
La Crosse	80	160[m]	.....	.....	.....	.....	13
Polk	16	1,845[m]	.....	.....	18	1,600[m]	.....
Portage	.....	.....	.....	.....	34	67,000	.....
Richland	8	17,834	.....	.....	6	98,342	No
Sauk	8	40,000	.....	.....	.....	.....	30
Sawyer	20	65,000	.....	.....	10	20,000	8 bridges, $12,000
Shawano	.....	.....	.....	.....	12	61,710	25 culverts
Sheboygan	6	7,500	.....	.....	75	140,980[g]	22 bridges, 83 culverts
Vernon	17	51,700	2	7,000[g]	0.25	1,700[g]	9 bridges, $43,000
Walworth	.....	.....	.....	.....	6	26,356[g]	1 bridge, 67 concr. culv.
Waushara	21	15,000	.....	.....	100,000	76,000	No

[g]—Includes grading. [b]—Oil treatment. [l]—Includes surfacing. [m]—Per mile. [s]—"Stamp sand." [q]—Per square yard. [y]—Per cubic yard.

ROAD IMPROVEMENT DONE IN 1922

County.	Bit. Macadam (M) and Bit. Concrete (C): Amount.	Bit. Macadam (M) and Bit. Concrete (C): Total Cost.	Cement Concrete (R = reinforced.): Amount. Miles or sq.yds.	Cement Concrete (R = reinforced.): Total Cost.	Brick: Amount. Miles or sq.yds.	Brick: Total Cost.
Arizona:						
Graham	....	....	6	$150,000[d]	....	....
Maricopa	....	.....	200	22,000[m]	....	....
Colorado:						
Logan	....	....	2.3	69,000	....	....
Mesa	....	....	1.25	43,390	....	....
Connecticut (Towns):						
Darien	1.25M	$15,400[e]	3.33	85,000	....	....
New London	2M	32,000[e]	....	....	....	....
Windsor	....	....	....	....	....	....
Illinois:						
Cass	....	....	7	200,000	....	....
Fulton	....	....	2	44,000	....	....
Greene	....	....	8R	192,000[b]	....	....
Jasper	....	....	7	132,000	....	....
Kane	....	....	170,000	2.00[s]	....	....
Peoria	....	....	2R	59,000[c]	....	....
Richland	....	....	9R	252,000[d]	....	....
Sangamon	....	....	47	1,225,000[d]	....	....
Stephenson	....	....	10	300,000	....	....
Wayne	....	....	12R	.....	....	....
Williamson	....	....	6.8	203,550[d]	....	....
Winnebago	....	....	16	422,544	....	....
Indiana,						
Henry	....	....	20	550,000	....	....
Madison	....	....	15½	480,200[d]	....	....
Vigo	....	....	10.42	370,600[d]	8.76	$525,000
Iowa:						
Buchanan	....	....	17R	402,000	....	....
Hancock	....	....	14R	360,000	....	....
Kossuth	....	....	11.05R	320,000	....	....
Woodbury	....	....	15R	....	....	....
Kansas:						
Allen	....	....	8	276,300[b]	....	....
Barton	....	....	36,000	2.50[s]	....	....
Bourbon	M	317,649	....	....	....	....
Brown	....	....	R	100,000[d]	....	....
Crawford	....	....	.26	27,000[m]	4	32,000[m]
Lyon	....	....	4	160,000	....	....
Ottawa	....	....	4⅓	2.82[s]	....	....
Reno	....	....	....	....	....	....
Sedgwick	....	....	21	31,200[m]	16	42,000[m]
					5.5	63,000[m]
Kentucky:						
Boyle	½M	5,000[d]	....	....	....	....
Clark	C	33,933	....	....	....	....
Jefferson	....	....	4½R	180,000	....	....
						....
Louisiana:						
Ouachita	1¼M	32,000[d]	....	....	....	....
Michigan:						
Cass	....	....	6R 6	170,000[d] 165,000	....	....
Eaton	....	....	5,111	12,573[am]	....	....
Emmet	....	....	4¾	86,660[d]	....	....
Hillsdale	....	....	1½	45,000	....	....
Kalamazoo	7.5C	34,000[dm]	20	32,000[dm]	....	....
Kent	4.5C	30,500[dm]	5	20,160[dm]	....	....
Keweenaw	10M	18,264[m]	....	....	....	....
Macomb	3C	....	15	....	....	....
Muskegon	4¾M	21,000[dm]	8R ½ 1R 7	2.30[s] 2.18[s] 30,000 28,000[m]	....	....
Ottawa	....	....				
Minnesota:						
Houston	....	....	648R	1,820	....	....
Meeker	2C	57,000	....	....	....	....
Montana:						
Gallatin	5.5M	176,229[e]	....	....	....	....

ROAD IMPROVEMENT DONE IN 1922—(Continued)

County.	Bit. Macadam (M) and Blt. Concrete (C). Amount. Miles or sq. yds.	Bit. Macadam (M) and Blt. Concrete (C). Total Cost.	Cement Concrete (R = reinforced). Amount. Miles or sq. yds.	Cement Concrete (R = reinforced). Total Cost.	Brick. Amount. Miles or sq. yds.	Brick. Total Cost.
Ohio:						
Allen	9.00C 8.00M	....	1.00R	....	12.00	....
Ashtabula	247,000M	$578,500[d]	....	....	73,660	$799,000[d]
Carroll	5.84M	29,854[d]	....	....	9.45	36,540[d]
Clark	32,660M	58,213[a]	....	....	....	....
Clinton	....	....	....	....	7.55	42,500[md]
Erie	....	....	....	$175,000	....	....
Fairfield	3M	70,000	....	....	....	....
Hancock	36,000C	100,000[d]	29,000R	75,000[d]	....	....
Harrison	4M	139,000	....	....	....	....
Henry	4¾M	78,000	6¼R	123,000	....	....
Holmes	....	....	4.31	99,300[d]	2.5	62,500[d]
Lucas	118,350M	2.23[a]	38,871R 1,151	3.52[d] 2.92	....	....
Madison	7,479M	8,884	....	....	....	....
Marion	6.87M 2.06C	195,621[d] 52,855	....	....	7.6	214,310[d]
Medina	2.63M	44,894	1.74	33,500	....	....
Ottawa	....	....	3.62R	93,000	0.99	41,000
Paulding	....	....	6.06R	150,000	....	....
Richland	3.0M	50,000[d]	1.5R 4.5	60,000[d] 110,000	1.5	45,000[d]
Sandusky	....	....	1.5R	25,000[d]	11.3	38,000[d]
Trumbull	3.39M 2.55C	90,955[d] 44,883	15.92R	445,419[d]	5.66	233,727[d]
Van Wert	....	....	6R	148,000[d]	....	....
Warren	7M	152,000[d]	....			
Oklahoma:						
Blaine	....	....	....	R7,212 2,966	....	....
Creek	....	....	5	27,800	....	....
Garfield	6C	33,000	....	....	....	....
South Carolina:						
Greenwood	....	....	1.1	29,000[d]	....	....
Texas:						
Cameron	....	....	15,000 cu. yd.	50,000[d]	....	....
Guadalupe	5M	30,000	....	....	....	....
Palo Pinto	....	....	R 3,000 cu yd.	46,000	....	....
Rockwall	....	....	5.3R	....	....	....
Runnels	....	....	....	....	14,000	2.86[a]
Schleicher	12M	169,000[d]	....	....	....	....
Tom Green	10M	161,000[d]	....	....	....	....
Washington	....	....	32R	864,000	....	....
Virginia:						
Albemarle	M	204,000	....	123,000	....	....
Tazewell	2M	3,000	....	....	....	....
Washington:						
Clarke	5.5C	143,000[c]	8	240,000[c]	....	....
Grays Harbor	....	....	6	30,000[c]	....	....
Lewis	....	....	5,532	13,558[c]	....	....
Pierce	....	....	38,000	98,153[a]	....	....
Skagit	....	....	9.88	200,329[d]	....	....
Whatcom	....	....	6	130,200[d]	....	....
West Virginia:						
Taylor	4.16M	108,100[d]	....	....	3,200	12,350[d]
Upshur	....	....	19,200	61,500[a]	....	....
Wood	5.3C	....	3.4	107,443[d]	....	....
Wisconsin:						
Fond du Lac	....	....	33.76R	979,040	....	....
Forest	....	....	5F	22.00[r]	....	....
Jackson	....	....	½R	10,515[s]	....	....
Jefferson	39C	....	39R	....	....	....
La Crosse	32M	12,000[m]	....	....	....	....
Richland	....	....	¼R	7,748[s]	....	....
Sheboygan	....	....	0.5R	3,500[d]	....	....
Vernon	4,000M	8,000[c]	30,000R	110,000[c]	....	....
Walworth	....	....	28R	700,451[d]	....	....

NOTE: Cost includes grading unless otherwise noted. [a]Does not include grading. [b]Includes bridges. [c]Includes culverts. [d]Includes bridges and culverts. [m]Per mile. [s]Per square yard. [r]Per cubic yard.

Highway Statistics

(*Continued from page* 137)

In a later issue we will give additional data concerning the use of reinforcement by the different counties and the materials used by them in resurfacing old pavements. Also additional data similar to the above received too late for inclusion in this issue.

The following information was given in answer to the questions: How much money, including County, State, Federal and other appropriations, was spent during 1922 for highway work in your county, under county or state supervision?

How much money is available (County, State, Federal and other funds) for highway work in your county in 1923?

Please give the amount (in miles or square yards) of each kind of road improvement done last year under state or county supervision, and the cost of each for the season.

What kinds of highway work and what amount of each do you contemplate doing in 1923?

Highway Engineers in Demand

The American Association of Engineers reported a few days ago that, in view of the fact that the highway programs for this year aggregate nearly three-quarters of a million dollars, "very few highway engineers of experience are available for employment, and it will be necessary for the highway commissions to engage inexperienced men for their staffs or obtain young men who are graduating from universities this year."

ROAD WORK CONTEMPLATED FOR 1923

County	Kind and Amount of Work.
Arizona:	
Flagstaff	Grade and drain earth roads.
Graham	16 mi. concrete or asphalt.
Phoenix	Concrete.
Navajo	Gravel construction, $30,000.
Pinal	40 mi. grading.
Yuma	42 mi. bit. concrete, 30 mi. gravel surface.
Arkansas:	
Hempstead	2.7 mi. concrete or asphalt.
Polk	Finishing last year's grading & graveling.
Colorado:	
Cheyenne	Grade 30 miles.
Clear Creek	Gravel and rock work.
Costilla	Grading.
Delta	5 mi. gravel surf., 600 ft. steel bridge.
Elbert	Grading and bridges.
La Plata	8 mi. gravel, 20 mi. grading.
Logan	2.7 mi. concrete, 30 mi. gravel, 2 concrete bridges, 2,500 mi. maintenance.
Mesa	Graveling $35,000, grad'g $30,000, bridges, culverts, etc., $30,000.
Rio Blanco	1.8 mi. grading and gravel, reconstruct 50 mi. earth.
Rio Grande	Grading $59,000.
Sedgwick	1,600 ft. bridge $40,000.
Connecticut: (Towns)	
Darien	150 ml. bit. macadam.
Fairfield	2 mi. gravel.
Lynn	8,000 ft. plain macadam.
Warren	Repair dirt road and culverts.
Windsor	Grading, plain macadam, gravel, repairs.
Delaware:	
New Castle	Maint. 180 mi. improved & 770 mi. earth road; concrete & bit. concr. constr.
Florida:	
Broward	Asphalt surface on existing macadam.
Glades	8 mi. plain macadam.
Pinellas	Bonds for 90 mi. hard roads to be voted on May 2.
St. Lucie	8 mi. bit. macadam, 26 mi. w. b. macadam, surface treated.
Illinois:	
Cass	25 ml. grading, oil 150 mi.
Christian	Bridges, culverts, grading, oiling.
De Witt	Maintenance only.
Fulton	100 mi. earth surface, 2 mi. concrete, 45 bridges, culverts.
Hancock	Grading.
Kane	22 mi. concrete, resurfacing gravel.
Mason	7 mi. gravel, 10 mi. concrete.
Massac	29½ mi. gravel.
Monroe	Grade and oil.
Peoria	22 mi. concrete, 100 mi. grading, 160 ml. oiling.
Pulaski	Grading $35,000, gravel $10,000.
Randolph	Grading.
Richland	Grading and bridges.
Sangamon	Reinforced concrete roads.
Stark	6 mi. concrete road with bridges.
Stephenson	20 mi. 18-ft. concrete.
Wayne	100 ml. grading.
Whiteside	10-ft. concrete road, $80,000.
Will	Bridges $15,000, roads $190,000.
Williamson	22 mi. concrete.
Winnebago	10 ml. concrete, macadam and gravel.
Woodford	Grade & bridges 10.5 ml.; maint., resurface and oil 42 mi.
Indiana:	
Henry	Reditch & resurface with gravel & stone.
Jasper	Gravel and crushed limestone.
Jennings	Macadam $115,000, gravel $10,000.
Madison	7½ mi. concrete, 1 mi. gravel, 75-ft. steel bridge.
Posey	Gravel roads.
Shelby	Gravel roads.
Vigo	10 mi. vibrolithic concrete, 18 mi. gravel.
Iowa:	
Adams	7 mi. grading.
Appanoose	Grading, bridges and culverts.
Audubon	Blade grading only.
Benton	Repair $40,000, bridges $75,000.
Boone	Grading $25,000, graveling $25,000, bridges and culverts $75,000.
Bremer	18 mi. grading, 10 mi. graveling.
Buchanan	2 mi. concrete.
Buena Vista	4 mi. gravel, 18,000 ft. culverts.
Cerro Gordo	20 mi. grading, 20 mi. graveling.
Chickasaw	10 mi. grading, 32 culverts.
Clay	7 mi. grading, 20 mi. graveling.
Clayton	15 mi. grading & draining, 15 bridges.
Crawford	20 mi. earth road reconst., 20 mi. gravel.
Decatur	Grading and bridges.
Des Moines	Pave 1¼ miles.
Dickinson	Graveling $12,000, resurfacing gravel $12,000, bridge $10,000.
Emmet	Resurface and gravel 18 mi.
Floyd	21 mi. road.
Greene	20 mi. permanent grade & gravel, bridges and culverts.
Grundy	10 mi. grading.

County	Kind and Amount of Work.
Iowa (Continued)	
Guthrie	125,000 cu. yds. grading, 26 bridges and culverts.
Hamilton	75,000 cu. yds. grading, 20,000 cu. yds. graveling.
Hancock	15 mi. grading and graveling.
Harrison	20 mi. grading.
Howard	2 mi. permanent grading, 10.5 mi. graveling, 10 mi. tiling.
Jackson	Grading $100,000, bridges $70,000.
Jefferson	21 mi. grading, 80,000 ft. tile.
Jones	25 mi. grading, 10 mi. gravel.
Kossuth	18 mi. concrete, 16 mi. grading.
Lucas	Maintenance only.
Lyon	42 mi. grading, 15 mi. gravel.
Marion	20 mi. grading, drains, bridges & culverts.
Mitchell	13 mi. gravel, 6 mi. grading, 50 concrete bridges.
Osceola	11 mi. grading, 16 mi. graveling.
Pocahontas	25 mi. extensive resurfacing of gravel (500-1,000 yds. per mile).
Pottawattamie	Grading.
Sac	20 mi. gravel surfacing, $80,000 for bridges and culverts.
Tama	30 mi. earth road.
Union	10 mi. permanent grade, 50 mi. blade grader, 50 bridges and culverts.
Van Buren	16 mi. primary road grading $100,000, bridges $40,000.
Webster	Graveling & grad. $60,000, bridges $60,000.
Woodbury	25.5 mi. concr. paving, 16.5 mi. heavy grading and bridges and culverts.
Worth	15 mi. grading, 7½ mi. gravel, 6 bridges, 30 culverts.
Kansas:	
Allen	16 mi. concrete, 4 mi. gravel, 13 ml. bit. macadam.
Barber	75 mi. grading $4,500, 2 conc. bridges $6,000, conc. overflow $2,000, 9 culverts $2,500, paint steel bridges $2,000.
Barton	2¾ mi. grading and bridges.
Bourbon	19 mi. bit. surfc., 4 mi. bit. mac. on 18 ft. brick, uncompleted work on contract $15,192.76.
Brown	Culverts & bridges $60,000, 10 mi. grading.
Butler	10½ mi. brick, 6 mi. gravel, 240 mi. grad.
Cloud	75 mi. temporary grading.
Crawford	3 mi. conc. 18 ft. wide, 4 mi. bit. macadam, 5 mi. chat.
Ellis	110 mi. grad., cuts, fills & dragging.
Geary	Earth grading & culvert work.
Graham	3 mi. earth surfacing.
Gray	400 mi. blade grader $14,000, fills & cuts, 27,700 cu. yds. $8,310.
Harvey	Grading and sand surfacing.
Hodgeman	27 mi. grading, 67 mi. regrading.
Jackson	8.79 mi. earth work and bridges.
Kingman	Backfill to bridges constructed previous year.
Labette	12 mi. grading, 25 mi. gravel resurfacing.
Lincoln	Grading, cuts & fills $25,000, bridges and culverts $20,000.
Lyon	11 mi. pavement.
Osage	Heavy grading, $20,000.
Ottawa	60 mi. blade grading, ¾ mi. 18 ft. to 50 ft. pavement.
Rawlins	90,000 cu. yd. earth grading, bridges and culverts.
Reno	4 mile brick paving, 2 large rein. concrete bridges.
Republic	Grading, constr. bridges and culverts.
Riley	Graveling, grading.
Sedgwick	6 mi. conc., 6½ mi. brick.
Seward	8½ mi. clay surfacing, 11 mi. blade work. 4 mi. fills by Fresno.
Thomas	Resurface all earth work, 3 bridges.
Wabaunsee	100 mi. grading, 2 mi. gravel.
Kentucky:	
Allen	Grading and graveling.
Boyle	11 mi. resurfacing macadam.
Clark	Surface treated waterbound macadam.
Crittenden	8½ mi. surfacing, 8.8 mi. gravel & drain
Gallatin	Only patching and maintenance.
Jefferson	8 mi. waterbound macadam, 4 mi. gravel.
Oldham	Repair only, $40,000.
Rockcastle	3 mi. grade and macadam, 5 mi. macadam.
Whitley	15 mi. surfacing.
Woodford	Reconstructing, surface treatment.
Louisiana:	
Beauregard	38 mi. gravel, 34 mi. gravel surface.
Caddo	12 mi. paving over old gravel & macadam.
Claiborne	16 mi. sand-clay gravel.
Lafourche	8 mi. concrete road.
Lincoln	63 mi. gravel road.
Ouachita	7 mi. asph. conc., 25 mi. gravel surface
Rapides	60 mi. gravel road.
St. Landry	Gravel rd. with conc. culverts & bridges.
Michigan:	
Branch	9 ft. gravel, 24-ft. grade, $120,000; 18-ft. conc., 26-ft. grade, $30,000.
Cass	12 ml. conc., 11 mi. bit. mac., 10 mi. gravel.
Charlevoix	7 mi. conc., 4 mi. gravel.
Chippewa	13 mi. grading, 8 mi. mac., 5 mi. gravel.

ROAD WORK CONTEMPLATED FOR 1923—(Continued)

County — Kind and Amount of Work.

Michigan (Continued)
Delta .....8 mi. mac., 15 mi. gravel, 1½ mi. concrete.
Eaton .....8½ mi. gravel, 5½ mi. concrete.
Emmet .....3 mi. conc. or bit. macadam, 24 mi. gravel.
Genesee.....39 mi. gravel, 1½ mi. pavement.
Hillsdale .....20 mi. 16-ft. gravel, 1 mi. 20-ft. concrete.
Kalamazoo ...7 mi. gravel, 8 mi. waterbound macadam, 12 mi. pavement.
Kent .....5.5 mi. grade, 18 mi. gravel, 15.4 mi. conc.
Keweenaw ...New construction $100,000.
Lake .....8 mi. gravel.
Luce .....6 mi. grade, $25,000; 1½ mi. gravel, $9,000. 5 mi. water bound macadam, $46,000.
Macomb .....20 mi. cement concrete, 6 mi. gravel.
Muskegon ....13½ mi. concrete, 8 mi. surface treated macadam, 23 mi. gravel.
Ottawa .....6 mi. grading, 15 mi. rein.-conc. pavement, 2 conc. bridges.
St. Joseph.....8 mi. concrete, 15 mi. gravel.

Minnesota:
Aitkin .....Gravel $27,800.
Benton .....12 mi. grading, 10 mi. gravel surfacing, 10 mi. clay surfacing.
Big Stone ....8½ mi. grading and graveling.
Blue Earth....30 mi. grading, 30 mi. graveling.
Brown .....Grading and graveling and 1 bridge.
Carlton .....50 mi. grading, 32 mi. gravel.
Carver .....11 mi. new grading & graveling; old work 2.4 mi. grading, including 1 culvert & 2 concrete bridges.
Chisago .....Construct, $30,000; bridges, $10,000.
Clay .....Grading.
Cottonwood ...Grading, $40,000; bridges, $52,000; gravel, $15,000.
Dakota .....30 mi. grading, 20 mi. gravel.
Dodge .....22 mi. grading, 30½ mi. gravel.
Freeborn .....10 mi. grading, 25 mi. gravel.
Goodhue .....60 mi. gravel, 22 mi. grading.
Grant .....5 mi. grading.
Houston .....1 mi. grad. (heavy), 25 mi. light grading.
Hubbard .....6 mi. grading and surfacing.
Isanti .....Grading and gravel surfacing.
Jackson .....0 mi. grading, 55 mi. gravel surfacing.
Kandiyohi ....70 mil. gravel surface.
Lake of Woods. Some construction.
Lincoln .....10 mi. grading, 24 mi. gravel.
Lyon .....41.3 mi. grading, including 7,172½ ft. portable culvert material & 531.15 cu. yd. monolithic culverts, 9 mi. regravel, repaint 9 steel bridges, 14.35 mi. gravel.
McLeod .....13 mi. grading, 16 mi. gravel.
Mahnomen ....Grading.
Martin .....20 mi. grading, 30 mi. gravel surfacing, 10,000 lin. ft. guard rail, 270 cu. yd. concrete bridges & culverts.
Meeker .....Grading, gravel, bridges and culverts.
Mille Lacs.....Grad., gravel & 1 20-ft. re-concrete bridge.
Murray .....25 mi. grading.
Nobles .....Grading, $186,000; gravel, $60,000.
Otter Tail.....5 mi. guard rail, 13 mi. gravel, 8 mi. grading, 1 bridge.
Pine .....30 mi. grading.
Polk .....35-50 mi. grading.
Red Lake.....25 mi. grading, bridge & culvert work, 3½ mi. gravel.
Rice .....32 mil. gravel, 84 mi. grading.
Rock .....27 mi. gravel.
Sherburne ....Grading & gravel or clay surf., $60,000.
Sibley .....30 mi. grading; 39 mi. gravel.
Stearns .....25 mi. grading, 20 mi. gravel.
Steele .....32 mi. grading, 20 mi. gravel.
Stevens .....7.95 mi. grading, 71,000 cu. yd. earth rds.
Swift .....Grading & culverts. $90,000; bridges, $40,000; surfacing, $30,000.
Wadena .....50 mi. grading, 5 mi. earth surfacing, 1½ mi. graveling.
Washington...3.5 mi. grading & graveling.
Watonwan ...13½ mi. grading, 20 mi. gravel surface.
Wilkin .....19 mi. grading.
Winona .....15 mi. grading, 15 mi. gravel, 30 mi. turnpike with blade grader.
Wright .....15 mi. grading, 30 mi. gravel.

Montana:
Cascade .....24½ mi. gravel, $276,000; mostly earth. rd., some gravel surface.
Chouteau .....Nothing but necessary repair work.
Custer .....Same as in 1922.
Gallatin .....20 mi. gravel surface roads, 15 mi. grading and draining roads.
Granite .....16 mi. grading, gravel 15-ft. wide.
Hill .....12 mi. grading and gravel surface.
Madison .....8 mi. Federal aid, 20 mi. county.
Missoula .....12 mi. grading and gravel.

Nebraska:
Cheyenne .....12 mi. Federal aid.
Grant .....Grading and earth surfacing.
Lancaster ....Earth work and bridge construction.

New York:
Montgomery...¼ mi. mac., 1 mi. resurfacing, earth roads.
Warren .....5 mi. bit. macadam.

North Dakota:
Cass ....19 mi. grading and graveling.
Eddy .....10 mi. Federal aid.
Foster .....11 mi. Federal & State aid grading.

County — Kind and Amount of Work.

North Dakota (Continued)
Grant .....Earth, some graveling.
Hettinger ....10 mi. Federal highway earth.
McLean .....Small amount Federal road.
Morton .....Grading only.
Ramsey .....16 mi. grading, 16 mi. gravel on graded roads.
Traill .....Grading 8 mi. county highway and 8 mi. Federal highway.
Williams ....100.0 mi. grading, 30.0 mi. graveling.

Ohio:
Allen .....1 mi. bit. concrete, 9 mi. brick or concrete, 5 mi. plain macadam.
Ashland .....10 mi. brick or concrete, some macadam resurfacing.
Ashtabula ....15 mi. either 4-in. macadam or 4-in. brick.
Carroll .....2.65 mi. brick, 5.10 mi. grading, bridges and culverts.
Clark .....8-in. reinforced concrete, or bit. macadam or brick.
Clinton .....82 mi. bit. mac., 1.52 mi. waterbound mac.
Erie .....2 concrete sections, 1 macadam section.
Fairfield .....7½ mi. rein.-conc., 6½ mi. brick, 213 mi. county rd., 10 mi. township rd.
Harrison .....All bit. macadam.
Henry .....Macadam, $40,000; concrete or bit. macadam, $156,000.
Holmes .....Grading, graveling, semi-monolithic brick and plain concrete.
Lucas .....Cement concrete, sheet asphalt, brick, bit. macadam, asphalt concrete.
Madison .....2½ mi. new gravel, 60 mi. resurfacing old gravel and stone roads.
Medina .....2.67 mi. concrete, 1.5 mi. bit. mac., 5 mi. gravel, 3.76 mi. local stone, 4.71 mi. state road.
Ottawa .....5.61 mi concrete
Paulding .....3.56 mi. state rein.-conc. & bit. macadam.
Putnam .....5 mi. Ky. rock, 35 mi. surface treating, 20 mi. plain stone.
Richland .....Brick and concrete, $1,550,000.
Sandusky .....4.1 mi. brick, 5 mi. macadam (repair wk.)
Trumbull .....4.33 mi. brick on concrete base, 4.01 mi. concrete.
Van Wert .....6 mi. rein.-conc. or bit. macadam.
Warren ..... 87 mi. bit. macadam.

Oklahoma:
Beaver .....160 mi. grading, 72 concrete culverts.
Blaine .....Bridges & culverts, $25,000; road construction, $15,000.
Caddo .....Grading, graveling & claying, $80,000.
Creek .....20 mi. either conc. or asphalt surfacing.
Garfield .....Pavements & bridges & culverts, $30,000.
Grady .....Surfacing earth rds. & concrete bridges.
Jackson ..... 2 60-ft. steel trusses, 20 concrete culverts, 1,200 lin. ft. gravel 20-ft. roadway.
McIntosh .....20 small culverts, $5,000.
Tillman .....Rein.-conc. culverts, bridges, spillways & some hard surfacing.

So. Carolina:
Abbeville .....Finishing up top soil roads and improving others.
Anderson .....Grading, top soil, gravel, 2 bridges.
Greenwood ...1.13 mi. plain concrete, 7.14 mi. top soil.

So. Dakota:
Butte .....50 mi. earth grading, 3 or 4 bridges—$1,000 to $6,000.
Clay .....36 mi. grading, 22 mi. graveling.
Deuel .....100 mi. blade grader, 15 mi. earth grading, 20 mi. gravel surface.
Grant .....11 mi. state and federal, 15 mi. county.
Hanson .....Grading and bridge repairing.
Jackson .....Grading.
Kingsbury ....Grading and blading county roads.
Mellette .....50 mi. grading, 20 bridges, bridge fills.
Potter .....25 mi. new work, considerable repair on township roads.
Spink .....Earth roads, graveling surface, culvert, small bridges (all by co. owned equipment); State finish 33 mi. old contract.
Tripp .....30 mi. earth road.

Tennessee:
Clay .....35 mi. grading.
Grundy .....5½ mi. mac., 10 mi. grading & draining.
Johnson .....Repairing old grades, patching mac. rds.

Texas:
Bowie .....5.60 mi. gravel, 3,210 lin. ft. bridges, steel and creosoted timber trestles.
Brooks .....10 mi. caliche base gravel top.
Cameron .... 21 mi. 18-ft. rein.-conc. rd.
Coleman .....Gravel road, rein.-conc. & steel bridges.
Colorado .....7 mi. gravel.
Fannin .....5.78 mi. concrete, 41 mi. gravel.
Fayette .....Gravel surface and concrete structures.
Gillespie .....10 mi. gravel. 1 mi. bit. macadam.
Guadalupe ...Gravel, $65,000; bit. macadam, $90,000; bridges, $10,000.
Harris .....5 mi. reconstructed road.
Hidalgo .....34.3 mi. 1-in. rock asphalt resurfacing, 51 mi. high-class pavement.
Karnes .....14.5 mi. rock asphalt on macadam base.
Kaufman .....10.74 mi. gravel and bit. top.

(To be continued)

STATE HIGHWAY WORK IN 1922

State	Federal funds received for 1922	Highway funds furnished by state	Spent for roads under direct state supervision	State aid to counties, etc.	State subdivision for road work
Alabama	$1,013,048	$1,427,595	$2,440,643	None	Counties
Arizona	.....	.....	3,466,960	None	Counties
Arkansas	1,550,000	300,000	8,300,000	.....	Road Imp. Districts
California	2,551,143	15,628,822	18,179,965	None	.....
Colorado	1,267,028	4,437,319	5,704,347	$707,570	Counties
Idaho	900,000	1,200,000	2,000,000	None	.....
Illinois	2,164,187	2,164,187	22,453,661	None	Counties
Indiana	821,913	5,939,144	6,491,816	None	None
Kentucky	1,445,407	2,862,410	5,234,739	525,099	.....
Louisiana	513,226	1,287,709	4,073,251	None	Parish and road district
Maine	1,039,603	3,181,727	5,726,613	$18,000	Towns and cities
Maryland	427,086	3,670,000	4,100,000	None	Counties
Massachusetts	1,662,195	7,008,872	8,579,530	None	Municipalities
Michigan	1,324,239	10,000,000	20,789,698	1,407,825	Counties
Nebraska	1,500,000[c]	1,500,000[c]	3,000,000[c]	None	Divisions
Nevada	754,815	.....	1,329,184	.....	None
New Hampshire	305,922	1,262,511	2,564,233	None	.....
New Jersey	1,180,480	5,410,195	11,223,037	$500,000 to counties, $525,000 to townships. Counties advanced to state $4,632,362	Counties and townships
New York	6,556,164	17,185,390	29,022,659	$4,706,160	Counties, towns and villages
North Dakota	1,450,432	345,148	3,118,600	221,966 (maintenance)	Counties and townships
Ohio	3,000,000	9,000,000	18,000,000	None	Counties and townships
Oklahoma	2,213,986	2,876,215	6,090,201	.....	Counties and townships
Oregon	1,043,695	7,767,995	12,659,434	$1,024,558	Counties
Pennsylvania	5,482,123	21,561,361	37,186,866	118,809	Counties, boroughs, townships
Rhode Island	71,782	1,834,199	1,609,054	$20,600	Townships
South Carolina	1,499,566	1,701,361	3,200,927	587,885	Counties
Tennessee	2,746,154	3,650,000	5,404,853	789,000	Counties
Texas	5,317,283	2,905,693	17,900,000	2,905,693	Counties
Utah	927,336	1,305,222	2,232,557	None	Counties
Washington	956,063	6,264,847	7,220,910	None	Counties
West Virginia	534,907	4,500,000	6,000,000	.....	Counties
Wisconsin	1,438,504	1,700,000	14,131,981	785,000	Counties
Wyoming	538,401	1,241,041	1,779,442	None	.....

STATE HIGHWAY WORK IN 1923

State	Federal funds probably to be spent	Funds to be furnished by state	Method of raising funds	Work contemplated
Alabama	$2,000,000	$2,000,000	Bond issue voted in 1922	350 miles sand-clay, gravel, bit. concr.
Arizona	2,383,364	1,788,040[b]	Taxation	Grading and gravelling
Arkansas	(d)	.....	Gasoline and auto license tax	All types from grading to sheet asphalt
Colorado	5,272,700	60 per cent	Bond issue	64 mi. concrete, 102 mi. gravel and sand-clay, 58 mi. grading and drainage
Idaho	700,000	500,000	County co-operation	6 mi. paving, 300 mi. gravel or crushed rock
Illinois	2,797,889	$2,797,889	Motor fees and bond issue	1,000 mi. rigid pavement, 100 mi. semi-rigid, 250 mi. heavy grading
Indiana	5,000,000	2,500,000	Auto licenses and gasoline tax	150 mi. concrete, 7 mi. brick, 17 mi. bit. macadam, 17 mi. gravel
Kentucky	1,000,000[c]	4,000,000[c]	Motor licenses, gas tax county donations 3/40 sheriffs' revenue, 3/40 tax on bank deposits	120 mi. grading and draining, 40 mi. gravel, 60 mi. w. b. macadam, 80 mi. high type
Louisiana	600,000	5,000,000[b]	Vehicle license, gasoline tax, chauffeur licenses	Gravel surfacing and maintenance
Maine	1,065,912	3,400,000	State tax, auto fees, gasoline tax and bonds	2.24 mi. concrete, 30 mi. bit. macadam, 200 mi. gravel
Massachusetts	1,500,000	7,500,000	Auto fees and fines, assessments on municipalities and counties	Construction, $5,800,000; maintenance, $5,200,000
Maryland	554,540	2,650,000	Bond issue	150 mi., principally concrete
Michigan	2,400,000	10,000,000	Bonds	573 mi. gravel, 87 mi. stone and macadam, 318 mi. concrete
Nebraska	Legislative appropriation		will be made about May 1st.	
Nevada	3,490,000	$205,000	10c. tax per $100, gasoline tax, fees from licensed racing	163 mi. grading and gravelling, 12 mi. gravel only, 4¼ mi. concrete, 12 mi. asphalt macadam
New Hampshire	306,000[c]	1,260,000[c]	Auto registration fees and appropriation	50 mi. construction, 50 mi. reconstruction, 25 small bridges
New Jersey	628,581	8,000,000	Sale of bonds voted in 1922	Not yet decided
New York	6,274,000	19,000,000	State appropriation	Various
North Dakota	875,000[c]	200,000[c]	Motor license fees	400 mi. grading, 200 mi. gravel surfacing
Ohio	4,000,000	9,000,000	Direct taxes	Brick, concrete, asphalt and macadam
Oklahoma	3,000,000	4,000,000	Auto licenses, gas tax, ¼ mill levy, gross production, county and township bonds	300 mi. gravel road, 150 mi. concrete or better
Oregon	1,700,000	8,600,000	Bonds, gas and auto tax, ¼ mill tax	40 mi. paving, 400 mi. surfacing, 250 mi. grading
Pennsylvania	2,500,000	5,000,000	Appropriation, motor licenses, etc.	Construction by contract, maintenance by state forces
Rhode Island	400,000	1,700,000	Motor registration and taxation	1.3 mi. sheet asphalt, 9 mi. bit. concrete, 20 mi. concrete, 14 mi. bit. macadam
South Carolina	1,500,000	.....	Motor licenses, taxes, bond issues by counties	Sheet asphalt, asphalt concrete, concrete, sand-clay, top soil, gravel
Tennessee	2,500,000	2,500,000	Auto gas tax, county contributions	Various, from w. b. macadam to concrete with bit. surface
Texas	6,000,000	3,500,000	Auto registration fees	.....
Utah	1,800,000	26 per cent	State road tax or county bonds	19 mi. grading, 150 mi. gravel, 25 mi. hard surface, 2 underpasses or overheads
Washington	1,500,000	7,000,000	1 mill tax, 1c. gasoline tax and motor vehicle licenses	70 mi. concrete, 110 mi. surfacing and 15 bridges
West Virginia	696,086	12,500,000	Part of $50,000,000 bond issue, auto registration fees	Closing gaps in and extending present state routes—concrete, bit. macadam, bit. concrete, gravel, w. b. macadam
Wisconsin	2,000,000	2,000,000	Auto licenses	375 mi. concrete, 1,000 mi. gravel, 1,000 mi. grading and draining only
Wyoming	1,100,000	1,650,000	Oil royalties, gas tax and appropriation	500 mi. grading, 250 mi. gravel surfacing, 2,400 mi. maintenance

[a]—$788,040 of this by the counties. [b]—Includes parish funds under state supervision. [c]—Approximate.
(d)—Federal aid held up until state legislature enacts necessary laws.

Recent Legal Decisions

APPROPRIATION BY TOWNSHIP FOR STATE ROAD THROUGH IT HELD VALID

The Nebraska Supreme Court, State v. Bone Creek Township, 190 N. W. 586, holds that in a county under township organization, a township or town is a subdivision of state territory, convenient in area, for the purpose of carrying into effect limited powers governmental in their nature. Included in these governmental functions is the statutory power to direct the raising of money by taxation for the construction and the repairing of roads within the township and to make contracts necessary to the exercise of such power.

A township may, within legal limitations, appropriate money to defray a portion of the expense incurred by the state in voluntarily paving a road within the township. Public roads constructed and controlled exclusively by the state or a subdivision thereof are not "works of internal improvement," within the meaning of that terms as used in the constitutional provision prohibiting "donations to any railroad or other work of internal improvement, unless a proposition so to do shall have been first submitted to the qualified electors thereof, at an election by authority of law."

GUARANTEE OF PAVEMENT AGAINST DEFECT FOR ONE YEAR DISTINGUISHED FROM GUARANTY OF GENERAL REPAIRS

If the contract guarantees general repairs from usual wear and common use for one year, without regard to defective workmanship or material, it is not within the power of the city to include such costs in a pavement contract to be assessed against the abutting owner on the street. This the Alabama Supreme Court, City of Albany vs. Spragins, 93 So. 803, approves as the general rule established by the authorities. But an obligation by the contractor in such a contract to replace defective parts in such pavements and repair all defects to conform to the specifications within a year from acceptance is, the court holds, "a guaranty of his work and the quality of the material furnished by him for one year; and this did not render the contract illegal. The authority to make such provisions in a contract gives the municipality the proper means of self protection against defective work and material."

A clause in such a contract requiring the contractor to insure the safety of the public by proper precautions as to fencing, watching and lighting during the progress of the work and to keep the city harmless from his negligence in this respect, "neither increases nor diminishes the cost and expenses of the pavement to be assessed against the property abutting, as it adds no duty or liability on the contractor except what is already placed on him by the law," and does not render the contract invalid.

SUIT ON CHECK DEPOSITED WITH BID FOR PUBLIC CONTRACT

The Minnesota Supreme Court holds, Independent School Dist. No. 102 v. Farmers, etc., Bank, 190 N. W. 539, that a demand for the payment of and suit brought to recover upon a check deposited in connection with a bid submitted for the performance of a public contract was in legal effect a declaration of forfeiture, though no formal declaration for that purpose was made.There was no abandonment of the contract arising from the acceptance of such a bid, or of the districts right of forfeiture and to recover on the check, by mutual consent or otherwise, from the unsuccessful efforts of the parties to change the terms of the bid after acceptance.

CONSTRUCTION OF AMBIGUOUS PAVING BID

Paving proposals to contractors contained the following. "Bitulithic upon 5-inch Portland cement, concrete foundation, header, and curb as specified to be included in the price per square yard for paving."

The successful bidder offered to do the bitulithic paving for a specified sum per yard. The bid also read: "The above bid includes all curbing shown on plans—5,320 header—curb—5,160 ft. combined curb."

The ambiguity of this language presented the question, in an action for alleged balance on the contract, whether the bid per square yard for the paving was intended to include the cost of header and curbing without extra charge, as the city contended it did. The Iowa Supreme Court holds, James Horrabin & Co. v. City of Des Moines, 190 N. W. 380, that as the ambiguity was formulated by the bidder and included in his bid, it must be construed most strongly against him, and that the contract based thereon made the basis of figuring the cost only the area of the bitulithic paving and not the combined area of paving and header and curb.

EVIDENCE OF COST OF COMPLETING WORK HELD ADMISSIBLE WHERE COMPLETION PREVENTED

The Maryland Court of Appeals holds, Trustees of Aitz Chain Hebrew Cong. v. Butterhoff, 118 Atl. 658, that in an action for breach of a paving contract, where it has been shown that defendant had refused payment of the amount shown by the engineers; certificate to be due him and had ordered him to remove his implements, the contractor's testimony as to what it would have cost him to complete the work was admissible to ascertain the profit he would have made if allowed to complete it, if not inadmissible for other reasons.

CITY MAY PROTECT ITSELF AGAINST UNNECESSARY CUTTING OF NEW PAVEMENT

The Illinois Commerce Commission holds that the right of a city to protect new pavement from unnecessary cutting by a public utility for a reasonable number of years after it is laid must be recognized.

CHARTER RIGHTS AND MONOPOLY OF WATER IMPOSING OBLIGATION TO SERVE PUBLIC

The Pennsylvania Public Service Commission, on the complaint of the village of Tuscarora, holds that a water company which, by reason of its charter rights and its pre-emption of the only available water supply is in control of the situation, is under a corresponding obligation to serve the public.

PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 54 May, 1923 No. 5

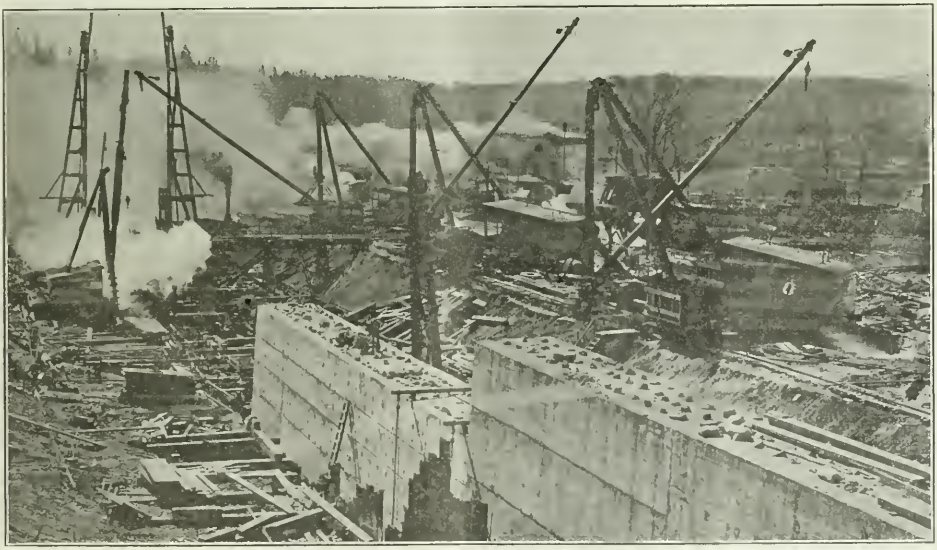
Progress on the Wanaque Project

Dam and twenty-five miles of aqueduct, including tunnels, to provide water for Newark and other municipalities in northern New Jersey. Unusual features in sheet piling and trench dewatering. Mucking by machinery in a nine-foot tunnel.

A water supply for the city of Newark, New Jersey, and, it is expected, for a number of other communities in northern New Jersey, is being developed by the North Jersey District Water Supply Commission by the impounding of the Wanaque river at a point about 25 miles north of Newark. This project was described in our issue of April 17th, 1920, and the beginning of the construction of the dam in our issue of August 7th, 1921.

Briefly, the project includes the construction, in the vicinity of Midvale, New Jersey, across the Wanaque river, with a water shed above the dam of 67.3 square miles, of a dam, and a conduit from this dam to connect with the existing conduit to Newark from its Pequannock supply, which is derived from a watershed a few miles west of the Wanaque shed. Provision will also be made for conduits leading to such other communities as may decide to use this supply.

The conduit will be carried in a general southerly direction from the Wanaque dam, following approximately the contour of the ground until it reaches Watchung Mountain near Great Notch, where it will pass through the mountain in a tunnel. The time required to construct the tunnel makes this a deciding feature in the completion of the entire



CORE WALL UNDER CONSTRUCTION.
Shows bonding stones on top of concrete; steel sheet-piling in foreground; derricks for handling sheet-piles and other material.

STEEL SHEET-PILING FORMING WATER-TIGHT CONTACT WITH ROCK 90 FEET BELOW GROUND SURFACE.

project and it was, therefore, decided to begin this as soon as possible and a contract for it was let last October and construction is now well under way, and the contract calls for its completion within 44 months after notice to begin work, or by July, 1926.

Owing to the uncertainty as to the number of municipalities that will associate themselves with the enterprise and use the water derived therefrom, certain of the features have not yet been finally decided upon. One of these is the height to which the dam will be raised. If only Newark uses the supply, provision for only 10,000,000 gallons a day will be necessary and the dam will not be raised to utilize the full storage capacity of the site. However, by raising the dam 25 feet higher, the capacity can be more than doubled and it would seem to be unfortunate if it is not possible to utilize this full capacity when doing so will necessitate such relatively slight increase in cost.

In view of the possible demands and the fact that it would cost almost, if not quite as much, to build a smaller tunnel as to build one with a capacity of 90,000,000 gallons a day, and in view of the great additional cost of duplicating the tunnel at any future time, one with this capacity was decided upon and is under construction.

The description of the construction of the dam in our issue of August 27, 1921, told of the driving of the sheet piles to a depth of nearly 100 feet, which is one of the very unusual features of this dam. The core wall has now been completed to a point about 20 feet above the ground surface and a part of the embankment has been carried up to the same height, and, except for some gravel filling work on the dam, has been discontinued for the time being until final determination has been made of the final height to which it is to be carried.

STEEL SHEET PILING

The engineers and contractor were naturally interested to learn, after the earth had been excavated between the two rows of sheet piling, how successful the driving of this had been in maintaining the sheeting vertical and in making good contact with the rock. It was found that the deviation from the vertical at the rock did not exceed 6 inches one way or the other, which was certainly as close as could be expected for piling driven 50 to 90 feet through coarse gravel. On top of the rock the slope of the ledge surface forced the piling out of line in places so that the trench, which was 20 feet wide at the top, varied from 18.6 to 24.4 feet at the rock surface. In general, the contact of the steel piling with the rock surface was found to be most satisfactory. In a few places the piles had encountered fragments of rock near the bottom and had been twisted out of their interlock and a few piles had apparently been overdriven and turned up or "fish-hooked" at the bottom. A few of the piles did not show tight contact and a small pile hammer was rigged on a derrick and such piles were driven to satisfactory contact. Those that turned up at the bottom were cut off with a torch. For a stretch of about 20 feet

CORE WALL TRENCH 100 FEET BELOW GROUND SURFACE.
Showing heavy timber bracing and large quantities of water in bottom of trench.

BLIND DRAIN DISCHARGING ALONG CENTER LINE OF CORE WALL.

on one side in the deepest section an additional set of short piling was driven inside the original set, but this was the only place where a double set was required.

The pressure against the piles was very great and was considerably increased by the ground water, but was reduced as described further on. The water tightness of the sheet piling held the ground water level at places 20 feet higher than the trench bottom and, in fact, it was necessary to open holes in the bottom of the sheet piling when it was desired to allow the ground water to escape into the trench.

As fast as the trench was excavated, the sheeting was supported by using 12 x 12-inch braces in bays spaced 10 feet on centers and with wales spaced 6 feet apart vertically for the upper 32 feet of the trench. Below this depth the spacing was at first reduced to 3 feet vertically, which was subsequently altered to double sets spaced at 6 feet, and here 14 x 14-inch rangers and 12 x 14-inch braces were used. After the trench had been excavated about 40 feet, the bracing began to show strain. One wale cracked longitudinally in about the middle and some of the braces cut into the wales as much as one-half inch and some of them split at the ends. The recurrence of this was prevented by substituting oak for pine bearing plates at the ends of the braces, and by framing the braces with even greater care so as to be sure that the entire end of the brace had a bearing on the bearing plate. Later, with the lowering of the ground water, the pressure decreased considerably and most of the braces when removed were cut out with no great difficulty and some were pulled out by a derrick without any cutting.

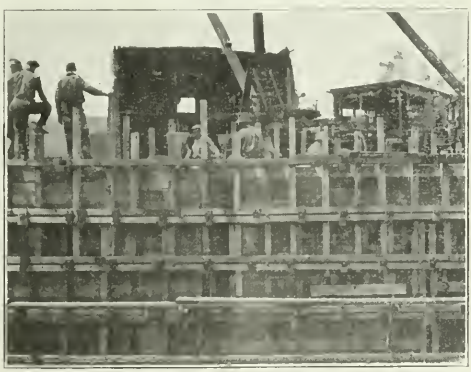
In driving the piles, the typical gang consisted of one foreman, one pile driver operator and six pile driver men for each rig, two rigs being run under one general foreman. High pressure steam was supplied from a central plant and no fireman was needed with the driving rig. The two rigs combined reached a maximum of 15,800 feet of sheet piling driven in one month, the minimum being 100 feet in January of 1922. The total amount driven in fourteen months of driving was 99,900 feet.

After the completion of the work an effort was made to draw and salvage some of the steel sheet piling. It was calculated, however, that the cost of this was greater than the value of the steel recovered, and the rest of the sheet piling was cut off with a torch at the surface of the ground.

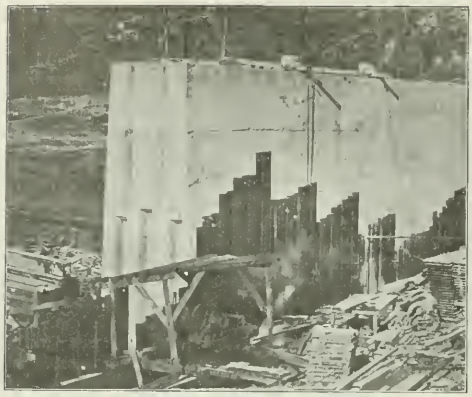
HANDLING GROUND WATER

Excavation inside the trench was begun at the north end with clamshell buckets operated from stiff-leg derricks running on a track on top of the west bank. (As described in the previous article, a wide trench was dug along each side of the core wall to a depth of about 10 or 12 feet and leveled off, giving a level path upon which to build the frame for guiding the piles and the pile driving rigs). Ground water was encountered immediately after the installation of the top set of bracings. Two 8-inch centrifugal dredge pumps, 60 inches in diameter, manufactured by the Morris Machine Company, were installed and, in addition to pumping water, removed a considerable yardage of sand and gravel from the trench, depositing it as part of the embankment on the downstream side of the dam. In addition, there were installed for handling the ground water, four No. 9 pulsometers, two 5-inch Emersons, two 5-inch Lawrence electric centrifugals and one 6-inch Westinghouse electric centrifugal. The amount of water removed was measured by a weir set in the trench by which the water was led to the river, and varied from a minimum of 200,000 gallons during the month of May to a maximum of 138,900,000 during August, 1921. In June, 1922, there was still being pumped 114,400,000 gallons, but this fell off rapidly with the completion of the core wall to 19,200,000 in August. During February, 1922, rates of 5,000 to 6,000 gallons per minute were pumped, when the longest stretch of deep trench was open.

In general, the ground water level remained about 20 feet above the level in the trench, resulting, as previously stated, in enormous pressure on the trench bracing. More or less water entered through seams in the rock. While working in the shallow trench



TYPICAL SECTION OF CORE WALL FORMS.



VERTICAL JOINT IN CORE WALL.

the water in the bottom was handled with no difficulty by means of blind drains or pipes close to the sheeting, but as the trench became deeper the quantity became greater so as to interfere with the placing of the concrete, and the ground water back of the sheeting began to leak through and flow onto the concrete at a point about 20 feet above the bottom of the trench. In order to prevent this, the ground water was lowered by burning holes in the sheeting near the bottom and driving through the sheeting, horizontally into the earth, 2-inch pipes pointed and perforated and three or four feet long. These permitted the ground water to drain away into the trench and most of the water entering the trench then came though these bleeder pipes and could be easily controlled.

When it came to placing concrete in the deepest sections, additional precautions were employed. The concrete was placed in stretches 10 to 20 feet in length and before placing that in the bottom of a new section, a concrete bulkhead or longitudinal wall 6 inches thick and 2 feet high was built two feet away from each line of sheeting. Between this wall and the sheeting a blind drain or pipe, sometimes connected with the bleeder pipes, was laid and carried the water to the pumps and away from the section under construction. The space between the two longitudinal bulkheads was then dry and the concrete could be placed there readily, and when it reached the top of the bulkheads, the space back of them was filled with concrete.

When concreting had been carried on in this way almost up to the main pumping plant, in the deepest part of the excavation, operations were begun near the other end, at a point where there was a natural sump in the rock, at which point another pump was installed, and the concrete was carried backward toward the main pumping plant.

It then became necessary to make the closure at this point, where a space about 40 feet in length had been left. Here longitudal parapet walls were built as described and the water which came underneath the sheet piles or through the bleeder pipes was thus concentrated between the parapets and the sheeting. The center wall was started between these parapets and carried to a height of about 6 feet, when the spaces between the concrete and the steel piling was filled with rock fragments and the top was sealed over with concrete extending from one wall of sheet piling to the other. Vertical pipes were carried up from the rock fragments at the bottom through the concrete to serve as pump suctions and the water was kept pumped down; the pumps being set slightly above the concrete already in place and raised from time to time as the concrete rose. By the time the concrete in this deep section had been completed, all of the other core wall concrete had been poured, pumping being continued until the last batch had been brought above ground water level.

CONCRETE WORK

The concrete was composed of gravel and sand obtained from a gravel bank about a half-mile away, where it was excavated by steam shovel, crushed and screened and hauled direct to the concrete mixer or stored for future use. The concrete mixing plant consisted of two Ransome mixers, size 53, located 300 feet from the core wall trench. The mixture was 1:21/2:5 and was deposited by the mixer into bottom-dump buckets, which were hauled to the core wall trench on narrow-gauge flat-cars and transferred to the forms by stiff-leg derricks. In placing the concrete in the deeper portions, it was deposited in hoppers feeding into vertical 10-inch steel pipe in order to prevent interference of the trench bracing.

Vertical joints between sections of concrete were made with tongue-and-groove. For binding at the horizontal joints, stones from 4 to 12 inches across were set into the top surface of the concrete. That these formed a perfect bond has been demonstrated during the past winter. At two or three places during the cold weather fine cracks have formed in the exposed top of the wall at points about midway between the construction joints, and these cracks have extended from one section to another across the horizontal construction joints. It is suggested that it might be preferable to substitute for these stone-bonded joints a tongue-and-groove joint similar to that used in the vertical construction joint, thus allowing a slight play of one section on the other. However, when the embankment has been placed against both faces of the core wall, and especially when the reservoir has been filled, it is not to be anticipated that there will be any appreciable temperature movements.

EMBANKMENT

After cutting off the sheeting and bringing the core wall above the elevation of the bottom of the trench, this trench was filled, the material on the upstream side consisting of clayey loam mixed with a considerable percentage of sand and gravel, while that on the downstream side was sand and gravel with no attempt at imperviousness. The impervious embankment on the upstream side was placed in layers about 6 inches deep and was thoroughly rolled and was found to compact to 3½ or 4 inches. This compacted material was carried up temporarily to the level of the ground surface and will be con-

tinued to the top of the core wall as the embankment construction proceeds.

The sand and gravel on the downstream side is being placed by hauling the material from borrow pits about one-half mile away, over narrow-gauge track with dinky engines, dumping the material on the embankment alongside the track and slushing it to place by means of water rather than moving it by hand or by scraper or dragline. Two men, using a 1⅛-inch nozzle can slush the dumped material down the embankment, which has a slope of about 3:1, as fast as a 3-car train can supply the material. At first, pumping the gravel onto the embankment from the borrow pit by the hydraulic method was tried, but it was found that hauling it by train and slushing by nozzle was cheaper. The surface water used in slushing the gravel into place flows off to the river through a trench. The embankment, although probably not impervious, as it is not intended to be, is thoroughly compacted and will undoubtedly experience no future settlement.

Unfortunately, the only fine material of the kind needed for the upstream side of the dam that could be found in the vicinity was located on the opposite side of the dam, while the gravel used for embankment on the downstream was located upstream from it. This made it desirable to leave an opening in the core wall from the ground level up, through which the embankment material could be carried. This opening will, of course, be filled before the embankment is carried much higher.

The river control conduit at the dam and the work on the tunnel will be described in the next issue. For the information used in this description we are indebted to Major A. H. Pratt, chief engineer, and N. C. Holdredge, assistant chief engineer, for the *Commission; and, for the photographs, to Major Pratt and the Commission.*

Cost of Placing Stone on Road

By Rodman Wiley *

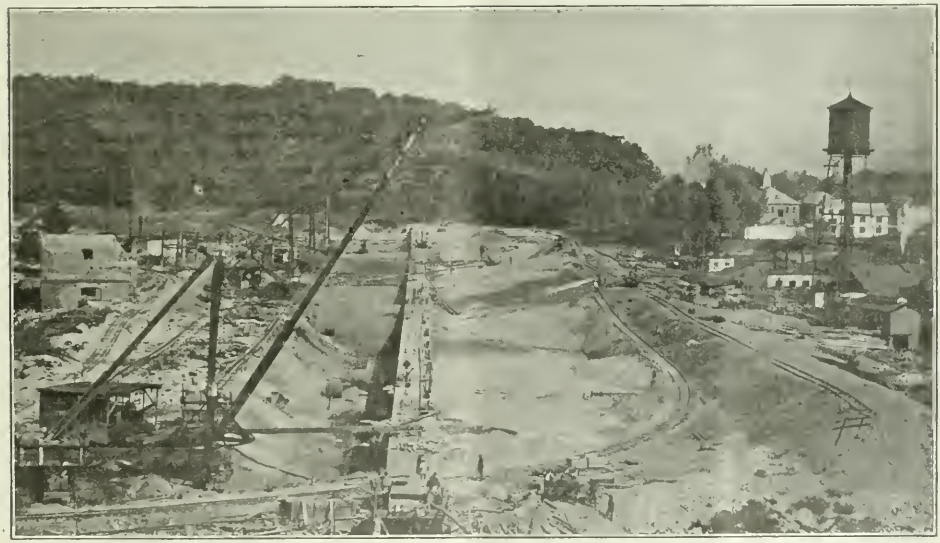
NOTE—The following estimate was prepared by Mr. Wiley and published in the "Scraper" the journal of the Kentucky Association of Highway Engineers, at the invitation of the secretary of the association, D. R. Lyman, that contractors furnish analyses of costs of the different pieces of contract work in that State. Mr. Lyman has expressed in the "Scraper" his opinion that if actual figures could be obtained, it would be shown that the averages of all highway contracts in that State during 1921 *and* 1922 *would show practically no profit and might even show a loss.*

CONDITIONS

Suppose that no quarry has been opened but that good limestone is available under a 9-foot overburden and that a 15-foot face is the most practicable to work.

The quarry will be located one-fourth of a mile

*Contractor, Wincester, Kentucky.



FILLING TRENCH ALONG COMPLETED CORE WALL.
Slushing gravel to place on the right (down stream) side; rolling impervious material at the left.

off the road to be built, necessitating the building of a truck road at the contractor's expense.

The royalty on stone is 5 cents per ton.

There is no water at the quarry site but it can be pumped from a creek one-fourth of a mile distant.

The average haul on stone is 4 miles.

The road to be improved is an old, worn-out macadam, with steep grades. It is necessary to eliminate the grades so that the macadam road is converted into an earth road for 50 per cent. of its length. Therefore the average haul will be 2 miles over worn-out macadam and 2 miles over earth road.

The quantity of stone to be crushed is 30,000 tons.

It is necessary to use imported labor, which, when all things are considered, will cost the contractor $3 per day.

The nearest railroad station to the quarry site is 10 miles.

It is considered that the crusher is up to date, with a capacity of 300 tons per day. The engine is to have sufficient capacity to run the crusher and air compressor. Cars and track to be used for delivering stone to the crusher.

The quarry is to be stripped with wheelers on an average haul of 600 feet for the earth removed.

ESTIMATE

Stripping—For every 3 cubic yards of overburden removed, 5 cubic yards of stone will be exposed. One cubic yard of stone in the solid weighs about 4,300 pounds. Five cubic yards of stone will weigh 21,500 pounds or 10¾ tons, therefore for every ton of stone taken out 0.28 cubic yards of earth must be removed. It will cost about 80 cents per cubic yard to strip. The cost per ton for stripping will be 0.28 x 80 cents = 22 cents.

Move In and Set Up—

Dismantling quarry equipment and loading, about	$300
Freight, about	500
Unload and move to job 10 miles	400
Set up (including scales)	600
Total	$1,800

Which for 30,000 tons is 6 cents per ton.

Building Road to Crusher—Road one-fourth mile long and 10 feet wide with stone 12 inches deep, including the grading, will cost about $2,000. This for 30,000 tons is 6 cents per ton.

Daily Quarry Cost—

Foreman	$10.00
Engineer	5.00
Drill Runner	5.00
Helper	4.00
Two feeders at $3.50	7.00
Hoist runner	3.50
Pump man	3.50
Blacksmith	5.00
Mule and driver to pull cars to foot of incline	4.00
Man to hook cars	3.00
Water boy	2.00
Five cars in quarry, 7 men to a car loading and sledging equals 35 men at $3.00	105.00
Coal and oil	15.00
Total	$172.00

This outfit will produce an average of 250 tons per day. $172 ÷ 250 = 69 cents per ton.

Cost in Bin—

	Per Ton
Stripping	$0.22
Move in and set up	.06
Building road	.06
Daily quarry cost	.69
Explosives (½ lb. per ton)	.12
Interest on investment, $15,000 at 6 per cent. is $900. This for 30,000 tons is	.03
Depreciation, 20 per cent. is $3,000, which for 30,000 tons is	.10
Total in bin	$1.28

Cost in Place on Road—

	Per Ton
Cost in bin	$1.28
Dressing subgrade, building berms, about $600 per mile, figuring 6,000 tons per mile	.10
Hauling 4 miles (2 miles over earth, 2 miles over worn-out macadam) at 40 cents per ton mile	1.60
Spreading, watering and rolling	.40
Royalty	.05
Interest on equipment, $20,000 at 6 per cent. is $1,200, which for 30,000 tons equals	.04
Depreciation, 20 per cent., is $4,000, which on 30,000 tons equals	.13
Bond	.06
Insurance	.10
Overhead — Superintendent, timekeeper, office, traveling expense, use of automobiles, interest on borrowed money etc. ,about 5 per cent	.20
General repairs	.10
Actual cost	$4.06

No profit included.

Montana's Highway Policy

The policy of the Montana Highway Department has been set forth at some length in the official organ of the department, "Montana Highway News." The salient features of this policy are given in abstract as follows:

What the Highway Department Proposes to Do

1. Take over the maintenance of the entire trunk highway system comprising 4,700 miles of road and pay all the cost of such maintenance.

2. Match Federal funds with the counties on a 27-20 per cent. basis, the counties supplying only 20 per cent. The Federal Government will supply 53 per cent.

3. Offer $225,000 to the counties annually as State Aid, same to be matched with county funds for improving important highways without Federal Aid.

How the Necessary Funds Will Be Secured

1. By an increase in motor vehicle fees, a two-cent gasoline tax, and revenue from royalties from Federal oil lands, as at present. There will be no general road levy on property for State road purposes.

What the Revenue Will Amount To

1. From motor vehicle registration fees, $1,200,000; from the gasoline tax, $500,000; from Federal oil royalties, $50,000; total, $1,750,000.

How the Money Will Be Spent

1. $705,000 will be spent in the maintenance of the 4,700-mile trunk system.

2. $600,000 will be matched, with $440,000 of county money against Federal Aid enabling the construction of $2,250,000 of Federal Aid roads on the trunk system.

3. $225,000 will be offered as State Aid for construction of roads not necessarily on the trunk system.

4. Not more than $110,000 will be used for administration expense, all office and overhead expense, or approximately 3 per cent. of the yearly accomplishment.

5 $90,000, or 3 per cent. of the value of improvements effected, will be spent for surveys and plans and all preconstruction engineering.

6. $20,000 will be set aside for capital expenditures, repairs, additions and replacement to the physical plant.

How the Counties Will Be Affected

1. They will be relieved of an annual expenditure of $275,000 for trunk highway maintenance.

2. $600,000 of State money will be spent within their borders in co-operation with Federal funds and 20 per cent. county funds.

3. $225,000 will be made available for them annually for important highway construction of a standard not necessarily as high as Federal Aid construction and not necessarily on the trunk system.

4. They will be saved $275,000 in maintenance, will secure $225,000 of State Aid and $600,000 of State money matched with their own funds against Federal Aid, a total $830,000 in excess of what they now get from motor vehicle fees.

How the Counties Will Be Affected

1. The policy will enable the matching of all Federal Aid apportioned to the State and not now matched, amounting to $6,500,000 and will prevent the loss of approximately $1,000,000 of this amount of Federal money next July 1.

Nevada Gasoline Tax Law

As we have already noted several times, a large and constantly increasing number of states are obtaining revenue by the taxing of gasoline used by motor vehicles, most of the revenue thus derived being used for highways, although at least one state, South Carolina, turns half of the revenue into the general treasury "to be used for defraying the ordinary expenses of the state government."

The different laws vary in the details of their application and operation. The following give the main points of the law approved on March 20th, 1923, by the state legislature of Nevada.

Motor vehicles are defined as including all vehicles, engines or machines, movable or immovable, which are operated or propelled by combustion of gasoline, distillate or other volatile and inflammable liquid fuels. Motor vehicle fuels are defined as including all fuel oils except kerosene oil. "Dealers" to which the law applies are defined as "any person, firm or corporation who imports or causes to be imported gasoline, distillate, benzine, naptha and such other volatile and inflammable liquids produced or compounded for operating or propelling motor vehicles as herein defined, for use, distribution or sale in, and after the same reaches the state of Nevada; and also any person, firm or corporation who produces, refines, manufactures or compounds such fuel in the state of Nevada for use, distribution or sale in this state."

Every such dealer must by the 15th of each month render a statement of all motor vehicle fuel sold or used by him during the preceding month and pay an excise tax of 2 cents per gallon thereon; this tax to be paid on or before the 15th of the month. Each dealer must keep a record in prescribed form of all purchases, receipts, use and sale of such fuel, these records including copies of all invoices or bills of sale and to be subject to inspection by the tax commission.

However, those using motor vehicle fuel "for the purpose of operating or propelling stationary gas engines, tractors, farm tractors, harvesting machines, aeroplanes or motorboats, or . . . for cleaning or dyeing or other commercial use of the same, except in a motor vehicle operated or intended to be operated upon any of the public highways of the state," will be reimbursed the amount of tax paid by him directly or indirectly upon presenting to the secretary an affidavit, accompanied by the original invoices, showing the purchase and stating the amount so purchased and used, the application being made within ninety days from the date of purchase.

From the excise taxes so received by the state treasurer, he shall pay annually the sum of $60,000 to the state highway fund and divide the balance among the counties of the state in proportion to the number of motor vehicles therein holding state licenses, which money shall be used by the counties as a road fund.

Violation of the act is considered a misdemeanor and is punishable by a fine of not exceeding $500 or imprisonment not to exceed six months, or both.

Gasoline Tax in Virginia

The chairman of the State Highway Commission of Virginia, H. G. Shirley, informs us that the Legislature has placed a three cent gas tax, two cents of which will go to state highways and one to feeder roads. It also passed a bill allowing the Governor to anticipate $1,700,000 under the mill tax appropriation, shown in his report as not being available until December.

Illinois Highways by Day Labor

In connection with its road program, the State of Illinois is operating four day-labor outfits on four separate sections of concrete paving work. C. M. Hathaway, engineer of construction of the Division of Highways, writes us that it is anticipated that these outfits will complete approximately 35 miles of the paving program during 1923. The Division has made active preparations in anticipation of car shortages, strikes, etc., by storing, between February 1st and May 1st, approximately 50% of the cement that will be required for this season as well as large amounts of coarse and fine aggregate.

Paving Prices in Centralia, Illinois

During the year 1922 six paving contracts were let by Centralia, Illinois, each being awarded to the lowest bidder, there being as many as ten bids to a letting. Payment was made in 6 per cent. special assessment bonds. Labor was obtained at 65c. an hour and teams at $1.00 an hour. There were no local materials and all had to be shipped in.

Asphaltic concrete with 2-inch wearing surface on a 6-inch base of 1:2½:5 concrete was let at 75c. per cubic yard for grading, $1.54 per square yard for concrete base, $1.56 for asphaltic concrete top, $1.02 per lineal foot for combined 12-inch curb and 24-inch gutter, $15 each for cast-iron inlets and $50 each for 4½-foot manholes.

Five contracts were awarded for Portland cement concrete pavements. These had a thickness of six inches at the sides and eight inches at the center and were made with a 1:2:3 mix using crushed limestone. The combined curb and gutter had a 6-inch curb and 12-inch gutter. Reinforcement was used in the pavement consisting of 35 lbs. of wire fabric per hundred square feet. The prices ranged from $2.42 to $2.60 per square yard for the concrete pavement, 10c. to 14c. per square yard for reinforcement, 85c. to $1.00 per lineal foot for curb and gutter, 65c. per cubic yard in all cases for grading, from 7c. to 9c. per lineal foot for ⅜-inch expansion joint, $11 to $15 each for castiron inlets and $40 to $50 for 4½-foot manholes.

Maintaining Earth Roads

An illustration of how figures may mislead is given in the report for the year 1921 of the Highway Commission of Utah, which has just been published. The Commission itself calls attention to this point in connection with its figures for maintenance of hard surface and of earth and gravel roads, respectively. The cost of maintenance of the former in 1921 averaged $154 per mile, while for earth and gravel roads it averaged only $86.20; but the latter cost was very low because of the fact that the roads were not adequately maintained. This is further emphasized by comparison with the cost of maintaining earth roads in Wisconsin during the same year, $187, and in South Carolina, where it was $252. On the other hand, the cost of maintaining the hard surface roads was unusually high, because a considerable mileage of them had been surfaced with Tarvia and the shoulders built up.

A Novelty in Highways

A highway has been patented by a Texas engineer, S. B. Moore, which is the most novel that has been brought to our notice for some time. The idea is that of building two lines of wheel ways of concrete, each wheel way being of sufficient width to allow for the varying gauges of vehicles; these concrete wheel ways occupying only perhaps one-quarter of the total width of the road and thus saving in cost. In order to provide for turning out or occasional divergence of the vehicle from the wheel ways, the spaces between and outside of these are filled with old road metal or asphalt macadam using gravel, and a wearing surface of asphalt macadam using broken stone is spread over the entire highway, thus giving a uniform wearing surface. In order to compel the vehicles to travel with their wheels directly above these concrete beams, a depression or wide rut is constructed in the surface over each beam, the sloping sides of which permit a vehicle to turn out but the depression being sufficient to make it much preferable to remain in the rut. Water falling on the road would naturally follow these ruts, and at low points in the grade the pavement is given a uniform cross slope toward one side or the other so as to lead the water into side ditches.

New Water Rates in Saint Paul

By James W. Routh, Consulting Engineer*

In preparing new rates to give necessary revenue increase, the system of uniform consumption charge and sliding scale of service charges was adopted.

After operating for ten years on the basis of rates established in 1912, the Saint Paul water department has found it necessary to revise its rate schedule.

In June, 1922, the Bureau of Municipal Research in a report prepared by the writer on the financial condition of the water department, pointed out the need for a revision of rates, and outlined certain principles which it was believed should govern the new rate basis. The revised schedule became operative January 1, 1923.

The new rates provide for a sliding scale of service charges, adjusted for meter size, with an even or level consumption charge of six cents per one hundred cubic feet of water. The old rates included no service charge, but imposed a minimum charge with the level rate of six cents per one hundred cubic feet. Tabulation of the former minimum charges and the new service charges is given below.

Meter Size	Former Minimum Rate Per Year	New Service Charge
⅝" & ½"	$ 3.60	$ 3.00
¾"	4.20	4.20
1"	6.00	7.20
1¼	7.20	10.20
1½"	13.20	13.20
2"	24.00	27.00
3"	54.00	60.00
4"	96.00	120.00
6"	216.00	240.00
8"	384.00	420.00
10"	600.00	600.00

The average domestic consumer uses about 400 cubic feet of water per month, at a present cost of 49 cents. Under the old rate schedule he paid 30 cents per month.

Statistics for the water department for 1912, when the old rate schedule was adopted, and for 1922, when the need for the new schedule became imperative, show graphically the reasons for the upward revision.

The amount of water provided in 1912 was 4,793,197 gallons; in 1922 this amount had increased to 7,548,000 gallons, or more than 50 per cent. The corresponding increase in revenue from the sale of water was only 30 per cent during that time.

During the war period, when many utilities found it necessary to increase their rates, the Saint Paul water department made no effort in that direction. But economy in operation cannot continue to offset increases in the cost of materials and supplies. And in addition, it has been necessary to augment the supply system and the distributing system with expensive improve-

*St. Paul Bureau of Municipal Research.

ments and additions. A new filtration plant, nearing completion at the present time, new reservoirs, and a prospective conduit or aqueduct connection between the present lake systems and the Mississippi River for additional supply, were cause for large bond issues. The sale of these bonds of course increased charges for interest and sinking fund, and there were corresponding decreases in revenue available for operation. The following table is significant in pointing out the increase in plant value, in operating costs, and in revenue during the ten year period prior to rate revision.

	1912	1922
Book Value of Plant	$5,655,954	$8,850,000
Sinking Fund	135,421	813,488
Gross Value	5,791,375	9,663,488
Outstanding Bonds	1,847,000	3,407,000
Net Investment	3,944,375	6,256,488
Net Increase in Value	.....	2,312,113
Revenue from Water Sales	370,700	441,550
Frontage Tax	64,495	76,901
Misc. Revenue	18,254	76,305
Total Revenue	453,449	594,756
Operating Expense	118,135	345,000(est.)
Interest and Sinking Fund	117,895	250,000(est.)

About 70 per cent of the supply is metered, and the department is making every effort to make the percentage 100. As an aid to this, the flat rates for unmetered water were materially increased by the recent rate revision, by the imposition of a uniform service charge of 25 cents per month on the existing rates.

Sewerage in England

With the construction about fifteen years ago of the sewerage system of Baltimore, the existence in America of large cities without sewers ceased. Although the construction of sewers was begun in England earlier than in this country, there are still cities in that country which have not adopted modern sewerage. The city of Hull, with a population of about 300,000 has only recently decided to construct a sewerage system at a cost of about a half million dollars. At the present time Hull is using the pail midden system and a recent inquiry showed that 8,342 houses in the city had no outlet at the rear and the night soil had to be carried through the houses. As might be expected, the medical health officer stated that the death rate from typhoid was larger than the average in large municipalities.

Fairmount Dam, Philadelphia

For many years an old timber dam has been used as part of the plant of the Water Works of Philadelphia and for a number of years the engineers have been calling attention to its dilapidated condition and the danger that it might go out at any freshet. Plans have at last been authorized for replacing this with a modern concrete structure which is estimated to cost $700,000.

The new dam will be about 1,510 feet long. The height is not great, about 800 feet of the length being from 12 to 15 feet deep, where the rock is exposed in the stream bed. At the eastern shore, adjacent to the aquarium, bedrock lies from 25 to 30 feet below water-level, and the dam will be carried down to this. Borings have been made to determine the depth and character of the rock at the site of the dam. The dam will be constructed of concrete with as large as possible a proportion of plums. The design has been made conservative with a very large factor of safety.

In constructing the dam, the present timber dam will be used as the upstream side of a cofferdam, while the downstream side and end of the cofferdam will be built of interlocking sheet piling.

It is expected that the coming summer will see the work of constructing the dam actively under way and that it will be completed within two years, and within less time if there is not an unusual number and intensity of floods in the river.

Erecting Tanks Downward

In constructing steel tanks for oil in Belgium, the practice is to build them from the top down instead of from the bottom up, according to "The Water Tower." While this refers to oil tanks, we presume that the same method would be used for water tanks, although these are usually made with heavier plates. The method may be described as follows:

The bottom of the tank is first assembled and riveted on the foundation. The top ring is then assembled on blocks about 8 inches high and riveted together. Large ratchet jacks with extra heavy footpieces are then placed on the bottom plate under this ring, a jack being placed under each plate, and all jacks are raised at the same speed until the plate is high enough to permit the second ring to be added. Where there are sixteen plates in a ring, two are bolted in place in each quarter of the tank and blocks placed under each one, following which the jacks are removed and the other half of the plates are put in place and blocked and the second ring riveted. This operation is repeated until the entire shell has been riveted in place, the bottom ring being bolted to the angle of the bottom plate instead of being raised on blocks.

Where the tank is not over 30 feet in diameter the roof is supported by a truss consisting of a center column 6 or 8 feet long from the bottom of which rods with turnbuckles run to the top of the top ring, thus forming trusses. Where the tank is over 30 feet in diameter, the center column is made in sections with lengths the same as the width of the sheets and is jacked up in the same way that the side plates are.

High-Class Country Roads

Union County, New Jersey, because of the large amount of traffic it must carry from neighboring great centers of population, finds it necessary to construct the highest class of roads. County Engineer Jacob L. Bauer reported that at the end of 1922 the county had 69 miles of improved highways, of which 33 were paved with sheet asphalt and asphaltic concrete, 22 miles with cement concrete, 10 miles with macadam and telford macadam, 1 mile with brick, nearly

a mile of asphalt block and a small stretch of granite block. A number of the roads constructed or contracted for last year are of three-inch sheet asphalt on a 6-inch concrete base, which is considered the highest type of construction. One stretch of such pavement, a trifle over a half-mile long and 40 feet wide, cost $45,524. This was in the city of Elizabeth and the county paid for only the central 22 feet, $20,740. The total expenditure for the county roads for the year was $348,450.

Hydraulic Dam Construction with Electric Dredge

A dam is being constructed by hydraulic fill by the Puget Sound Bridge and Dredging Company to provide a storage reservoir of the Wichita County Water Improvement District No. 1. The dam is located on Big Wichita river about 50 miles from Wichita Falls, Texas, and 8 miles from the nearest railroad station.

The dam is approximately 100 feet high at the deepest point, has side slopes varying from 3:1 to 2:1, is about 3,000 feet long and will contain more than 1,300,000 cubic yards. To carry the river during construction and serve as a permanent feature, there were constructed six concrete conduits, each 7 feet in diameter, at the lowest point in the river bed. These are equipped with gates and it has been computed that they will carry any flood likely to occur during the construction.

The river bed is underlaid with blue clay and shale. A row of steel sheet piles was used as a cut-off across the river channel and the first bench. From there to the end of the fill a ditch was excavated by dragline and steam shovel down to impervious material to receive the core wall.

The embankment is being built of material taken from the river immediately above the dam site and is composed of gravel, sand, clay and silt, with sand predominating. The material is excavated by means of a ladder dredge and pumped to the dam, where it is deposited in the ordinary method of hydraulic dam construction, the fine silt and disintegrated clay being washed into a center pool in the middle of the dam to form the core wall. Wooden bulkheads are used on the slopes of the dam to retain the material as it is deposited from the discharge pipe—a system that was successfully used in filling streets on the waterfront of Seattle. The waste water is returned to the pool above the dam. Care is taken to keep the center pool narrow enough and its bottom high enough not to endanger the stability of the coarser material forming the remainder of the dam because of hydrostatic pressure from within.

The water of Wichita river contains a large amount of mineral salts which are bad for boilers. This made steam power objectionable for the dredge. As fuel oil is abundant and cheap, this might have been used. However, the district had decided to build a high-tension power transmission line from Wichita Falls to the dam site, and the contractors had available the main elements essential for an electric dredge of the size and capacity desired, and therefore an electric dredge was decided upon.

The dredge was designed especially for this work by the contractors, the designing requiring sixty days. The keel was laid March 21st and the machinery installation completed and dredge ready in July, although actual operation did not begin until September, 1922. The dredge has a hull of wood 42 feet by 11 feet, which was launched into a pit dug by a dragline excavator in the bank of the river, deep enough to float the dredge even should the river go dry. The spuds are of wood 26 inches square and 76 feet long. All other parts of the dredge are of metal. The ladder is 75 feet long, carrying an 8-inch cutter shaft. The discharge pipe is 20 inches in diameter. The total power on the dredge was 2,100-h.p., this high power being provided to raise the excavated material to a high lift.

Groined Arches

Principle features of designs that long practice has demonstrated to be safe, including form and span of arch, size of columns and mix of concrete.

By far the largest number of covered reservoirs, filters, etc., that have been built in this country have had their roofs constructed of concrete as groined arches, only a very few having used reinforced concrete slabs for this purpose. The designing of such arches was the subject of a paper before the American Society of Civil Engineers by Philip O. Macqueen of Bay City, Michigan.

Mr. Macqueen states that designs of groined arches are entirely empirical, the exact designing from a strictly mathematical or even logical viewpoint being impossible. However, the groined arch has been used for more than two thousand years and, when carefully constructed, its safety is beyond question.

In order to obtain data on which to base a design which will embody what has been proved to be safe practice, the author has analyzed the designs of thirty different groined arches used for reservoir roofs in this country, ranging in date of construction from those at Albany, N. Y., built in 1899, to roofs built in Cleveland in 1916 and others designed in 1920 for the same city but not yet completed. These roofs varied in the clear span between columns from a minimum of 10 feet to a maximum of 19.16; in rise of intrados of from 1.5 feet to 5.0 and rise of extrados from 0.5 to 2.58 feet. In every case the thickness of the arch at the crown is 6 inches.

Mr. Macqueen states that while some groined arch roofs have failed, in each case the failure has been due to faulty foundations, poor concrete, or unusual stresses during construction, but no cases are on record of their having failed on account of poor design or excess loading.

Discussing the form of the arch, the author considers that the elliptical shape of intrados lends itself to a systematic arrangement at the

Data on Concrete Groined Arches for Reservoir Roofs

No.	Date.	Location.	Clear span ($2a$), in feet.	Rise of intrados (b), in feet.	Crown thickness (t), in feet.	Rise of extrados (h), in feet.	Span, center to center, of columns ($2c$), in feet.	Ratios: $\left(\frac{b}{2a}\right)$	Ratios: $\left(\frac{h}{b+t}\right)$	Average thickness of roof, in feet.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	1903	Watertown, N. Y.....	10.000	1.500	0.500	0.833	11.500	0.150	0.417	0.562
2	1909	Providence, R. I.....	10.250	2.500	0.500	1.250	11.917	0.244	0.417	0.635
3	1903	Ithaca, N. Y.....	10.500	1.500	0.500	0.833	12.000	0.143	0.417	0.568
4	1909	Springfield, Mass.....	11.333	2.000	0.500	1.250	13.000	0.177	0.500	0.566
5	1911	Toronto, Ont., Canada.....	11.333	2.000	0.500	1.167	13.000	0.177	0.467	0.582
6	1910	Owen Sound, Ont., Canada	11.500	2.500	0.500	1.167	13.000	0.218	0.388	0.625
7	1903	Washington, D. C.....	11.833	2.500	0.500	1.417	13.667	0.211	0.472	0.606
8	1899	Albany, N. Y.....	11.917	2.500	0.500	0.500	13.667	0.210	0.167	0.774
9	1900	Superior, Wis.	12.000	2.500	0.500	0.500	13.667	0.208	0.167	0.747
10	1903	Washington, D. C.....	12.167	2.500	0.500	1.417	14.000	0.206	0.472	0.600
11	1912	Roland Park, Md.....	13.000	2.667	0.500	1.500	14.667	0.205	0.473	0.593
12	1907	Philadelphia, Pa.	13.167	3.000	0.500	1.750	15.000	0.228	0.500	0.609
13	1907	Lawrence, Mass.	13.167	2.750	0.500	1.667	15.000	0.209	0.513	0.590
14	1908	Pittsburgh, Pa.	13.167	3.000	0.500	1.750	15.000	0.228	0.500	0.609
15	1904	Philadelphia, Pa.	13.417	3.000	0.500	1.750	15.250	0.224	0.500	0.607
16	1913	Baltimore, Md.	13.500	3.000	0.500	1.750	15.000	0.222	0.500	0.582
17	1912	Grand Rapids, Mich.....	13.833	3.000	0.500	1.833	15.000	0.217	0.524	0.543
18	1907	Philadelphia, Pa.	14.000	3.000	0.500	1.750	15.833	0.214	0.500	0.604
19	1902	Milford, Mass.	14.000	3.000	0.500	1.500	16.000	0.214	0.428	0.658
20	1909	Springfield, Mass.	14.000	2.750	0.500	1.500	16.000	0.196	0.462	0.623
21	1916	Cleveland, Ohio.....	14.080	3.500	0.500	2.000	15.750	0.249	0.500	0.618
22	1908	Columbus, Ohio.....	15.167	3.167	0.500	1.917	16.833	0.209	0.522	0.568
23	1905	Washington, D. C	15.500	3.500	0.500	2.083	18.000	0.226	0.522	0.646
24	1908	Pittsburg, Pa.	15.750	4.000	0.500	2.167	18.000	0.254	0.482	0.683
25	1912	New York City.....	16.000	3.750	0.500	2.000	18.000	0.234	0.470	0.653
26	1913	Minneapolis, Minn.	16.333	3.500	0.500	2.000	18.000	0.214	0.500	0.600
27	1913	Montreal, Que., Canada....	17.000	4.250	0.500	2.000	19.000	0.250	0.422	0.700
28	1912	New York City*.....	18.000	4.500	0.500	2.500	20.000	0.250	0.500	0.646
29	1912	New York City*.....	19.160	5.000	0.500	2.580	22.000	0.261	0.469	0.744
30	1920	Cleveland, Ohio*	17.960	4.500	0.500	2.500	20.292	0.253	0.500	0.675

*Under construction or proposed.

column supports, while the flattened form of the arch permits long spans with a minimum loss of headroom; and that the parabolic extrados gives a uniformly increasing thickness to the arch; and it is difficult to conceive that more effective curves could be used for the purpose.

As to span, he considers that 10 feet is too short to be economical, but that about 15 feet center to center of columns is considered good practice where the columns are less than 20 feet high, while for columns between 20 and 30 feet in height the span is usually 18 to 20 feet, the latter being probably the maximum that can be recommended for groined arch work.

In the matter of rise of intrados, he finds that the average in the case of the thirty roofs listed is represented by one-third the clear span of the arch minus 1.5, although the several arches vary from 80% of this to 111%. The practice as to rise of extrados he finds to be represented by one-half the sum of the rise of the intrados and the crown thickness.

As to the concrete mix used, the difference between a mixture of 1:2½:5 or 1:3:5 as compared with 1:2:4 would be 2% of the total cost with concrete at $15 per cubic yard, and he recommends the use of the richer mixture.

The normal loading for the roof, he states, is usually taken as two feet of earth plus a live load of 100 pounds per square foot. He thinks that the flat slab roof may be more economical for small, shallow reservoirs of an area of less than one acre on account of the lower cost of form work, but for deeper reservoirs covering an area of several acres the groined arch roof will prove much more economical.

Street Openings in Plainfield, New Jersey

In Plainfield, New Jersey, a separate permit must be obtained from the city engineer for each street opening and a deposit made of $10 for an opening of not more than 50 feet in length and $2.50 for each additional 50 feet; and, in addition to this, further deposits depending upon the kind of pavement, $7 per square yard being required for stone block, brick, asphalt or other material on a concrete foundation; $6 for cement concrete pavements; $4 for bituminous concrete or bituminous macadam on Telford base, or stone block on sand foundation, and $3 for macadam. The trench is backfilled by the applicant, but the pavements are replaced by the city and the cost deducted from the deposit and the balance returned six months after the date of the permit if the trench and the street surface are then in good condition.

The backfilling must be done in layers not more than 6 inches deep, thoroughly rammed, and also flushed with water if necessary. Any tunnelling

under a pavement having a concrete base must be backfilled with a concrete composed of one part Portland cement and nine parts of steam boiler cinders or other approved material completely filling the cavity. Where the pavement has a concrete base it is cut back 9 inches wider than the trench on each side and the edge of the old concrete bevelled so as to be 4 inches wider at the top than at the bottom; and the new concrete is made 2 inches thicker than the original and is reinforced with No. 10 expanded metal or equivalent wire fabric.

Curing a "Sick" Sewer System

An example of "Paralysis" of purpose due to lack of use and neglect of the sewers of Independence, Missouri.

By Leon B. Reynolds*

Independence is a city of about twelve thousand population, situated about nine miles east of Kansas City, Missouri. The topography of the city is rather rough, with an extreme range of over 150 feet in elevation. The business section occupies the highest ground and the drainage flows in five different directions. These draws fall rapidly and, of course, do not carry much water except during wet weather, and are often entirely dry.

The original sewer system was designed about 1899 and four outlets were provided with sewage disposal plants. The backbone of the system has remained unchanged and lateral extensions have been added as the city has grown. The original sewage disposal plant for each outlet consisted of a shallow septic tank and a contact bed, one of the earliest installations of this type in the country. The septic tanks were circular radial-flow tanks 5 to 8 feet deep; the contact beds were originally filled with alternate layers of brick and coke breeze. By the year 1908 the coke breeze had broken down and the beds had become clogged; at that time the filling material was removed and the beds were filled with layers of sand, stone, gravel, and brick. At the west plant a dosing tank and sprinkling filter were later constructed in order to purify the sewage more thoroughly. The contact beds were later abandoned entirely, the septic tanks ceased to function, due to their filling up with solids, and the sprinkling filter became clogged, due to excess of solid matter being carried over from the septic tank.

Early in 1921 the city engaged the firm of which the writer is a member to examine the sewer system and plants for treatment of sewage and to recommend the necessary improvements. A sanitary survey of the city was made to determine the number of houses connected to the present sewers. The authorities were startled to find that 1,500 houses, or more than half the total number in the city, were not connected to sewers; of these 1,500 houses not connected, 700 fronted on streets where sewers were already laid and sewer service was available, and 800 were in localities where no sewers had been laid. The amazing discovery that nearly one-quarter of the population occupied residences unconnected with the sewers started an agitation to compel the use of sewers where available.

Practically all of the existing lateral sewers were found to be provided with flush-tanks, 101 being the total number. Of this total only 32 were found to be operating, 41 were receiving no water due to the inlet being stopped up or turned off, and 28 were not flushing due to leakage through the siphon or the walls of the tank. In addition to the waste by

*Member of firm of Burns & McDonnell Engineering Co.

SOUTH TREATMENT PLANT DURING CONSTRUCTION.

leakage in the 28 which were not flushing, the water used by the 32 operating tanks would have been sufficient to allow each of the 101 tanks to discharge once every 16 hours. This condition was also rather startling to the city, and may be common to other cities.

Due to the small amount or lack of flow during the summer in the draws used as final outlets, the conditions below the sewage plants were very offensive. The north, east and south plants consisting of septic tanks and contact beds were practically not functioning at all and were entirely neglected, while the west plant consisting of septic tank and sprinkling filter was neglected and its efficiency was low. Damage suits had been threatened and one suit had already been filed by land owners below the outlets and the city was facing considerable litigation. If the Missouri State Board of Health had actively and efficiently regulated the disposal of sewage from cities of that state the existing conditions would have been remedied long before.

The most startling discovery of all was that the effluent from the inefficient west plant discharged into a draw about a mile and one-half above Fairmount Lake, located in one of Kansas City's amusement parks, on whose shore is the best natural bathing beach in the city. Physicians stated that they had treated numerous infections among bathers but the cause seemed to be unknown, and the public generally was not aware that the sewage from the west district, in which the city hospital was located, found its way into this lake. As soon as the real condition became public the owners of the amusement park threatened suit for damages unless the city installed a sterilization plant, and the city promptly installed a temporary plant of this kind to treat the effluent with liquid chlorine. In addition the owners of the amusement park treated the lake with liquid chlorine applied from a plant installed in a row-boat. The effect of these precautions was quickly noticed in the reduced bacterial content of the lake water.

A bond issue was put up to the people on the basis of the preliminary report by the engineers recommending new treatment plants consisting of Imhoff tanks, sludge beds, dosing tanks and sprinkling filters for the north, east and south districts and ejector pumping plants for the west, southwest, and southeast districts. The engineers conducted an educational campaign for the bonds and they were voted in June, 1921, by a vote of 7 to 1. Contracts were awarded in September, 1921, to Ray and Son of Baxter Springs, Kansas, for the construction work, and to Simplex Ejector Company of Chicago for the ejector equipment. The construction work was completed in August, 1922, and the plants have all been in operation since that time.

The south plant is designed for a flow of 500,000 gallons per day, the north plant for 200,000 gallons per day, and the east plant for 100,000 gallons per day. The settling chambers of the Imhoff tanks are designed for a two-hour retention period on the basis of the entire daily flow occurring during eighteen hours, with provision for reversal of flow.

The velocity of flow through the settling chambers varies from .003 to .008 feet per second; the total depth below sewage level ranges from 19 ft. 8 in. to 23 ft. 6 in. The ratio between gas vent surface and sludge room surface is approximately 1:4. Sufficient capacity is provided in the sludge compartment up to eighteen inches below the slot for storage of 150 days' sludge.

Sludge is withdrawn under hydrostatic head of 5 ft. 6 in to 6 ft. upon sludge beds having areas of 280 to 360 sq. ft. per thousand population. The sludge beds have a surface sand layer six inches thick and underdrains are four-inch drain tile.

The dosing tanks are of the ordinary tapered type. The sprinkling filters are designed to operate at the rate of 2,500,000 gallons per acre per day. The best local limestone in sizes from ¾-inches to 2½-inches was used for filling material with a depth varying from 5 ft. to 5 ft. 6 in. Distributors are of vitrified pipe encased in concrete; Merritt square-spray nozzles are used and underdrains are six-inch split drain tile. The total head through the plants from the sew-

SPRINKLING FILTER AT SOUTH TREATMENT PLANT, INDEPENDENCE, MO.

age level in the Imhoff tanks to the invert of the main drain from the filters is 14.6 feet at the north plant, 14.4 feet at the east plant and 17.8 feet at the south plant.

Ejector sewage pumping stations were constructed to pump the sewage from the west, southwest, and southeast districts into sewers draining by gravity into the south treatment plant. The west district is relatively small and its sewage, including that from the city hospital, is now prevented from being discharged into the bathing lake. The southwest and southeast districts are too low to drain by gravity into existing sewers.

At each ejector station there are two Simplex ejectors of 75 gallons capacity, two motor-driven Gardner vertical compressors with short belt and idler drive and Westinghouse automatic pressure regulator control. The discharge lines are six-inch cast iron pipes. At the west station the static head is 60 feet, at the southwest 24 feet and at the southeast 56 feet. A moderate speed of 250 r.p.m. was specified for the compressors in order to secure maximum service and reliability with a minimum of maintenance and attendance. Some difficulty was encountered with the unloader equipment due to unreliability of the local power, and bleeder tanks were installed on the discharge lines from the compressors to relieve the pressure and allow the compressor to start against a smaller pressure after any interruption of power of more than fifteen seconds.

The total cost of the three sewage treatment plants was $87,950, including land, and the cost of the ejector equipment was $11,735. The plants are under the supervision of the sewer superintendent, E. M. Riddle, who was formerly city engineer, and who is giving the plants the attention which they deserve. Some difficulty has been experienced thus far with the Imhoff tanks due to foaming, but the sludge is being kept down by raking and spraying with water, and conditions are improving. A removal of from 70 to 75 per cent. of the settleable solids is being secured and a good quality of sludge is being produced. The relative stability of the final effluent is showing a gradual improvement as the bacterial action in the filter beds becomes better established.

Philadelphia Sewer Specifications

For many years the Bureau of Surveys of Philadelphia has built sewers under specifications providing for a lump sum rather than unit price bids. Recently the Contractors' Association of Philadelphia has been co-operating with the chief engineer of the Bureau of Surveys in changing this plan to one more in conformity with modern methods.

In presenting the matter to the Bureau of Surveys, the secretary of the Contractors' Association urged that contractors be permitted to bid on inlets, manholes, house connections, curbing, etc., as items separate from the cost of the sewer itself; also make unit bids for excavation for different types of sewers, with additional prices for spurs and other appurtenances. It was also requested that a surety company guarantee be required for each proposal instead of a general bond for a contractor under which he could bid on fifty sewers if he desired. Another request was that contractors be furnished with plans and specifications that they can study in their own offices, rather than requiring them to inspect them in the office of the bureau, where frequently two or three are endeavoring to obtain the desired information from a single plan at the same time.

Replying to these suggestions, under date of March 14, J. A. Vogleson, chief engineer and surveyor, announced that at the next letting trial would be made of three of the changes desired, proposals being asked on items given in the summary of the work, a guarantee bond required for each bid for sewers when the bid exceeds $5,000, and blueprints being purchaseable by contractors from an authorized blueprinter.

The contractors also suggested that core borings be made for determining the nature of the ground and that the bureau investigate the qualifications of bidders before awarding contracts, but apparently these suggestions were not adopted by the bureau, nor was the desire of the contractors that bids be received for excavation of different types of sewers. It is possible, however, that the bureau is taking further time to consider these requests before making final decision.

Feeding a Six-Bag Paver

In constructing an 11-mile section of 18-foot concrete pavement on the Pacific Highway near Canyonville, Oregon, the contractor, S. A. Moceri of Tacoma, found himself encountered with the necessity of hauling his aggregate and cement by truck for 17 miles over a road containing four miles of a continuous 5½% grade and two miles of a 2% grade. This long haul made the delivery of materials on schedule uncertain and, to prevent delays, they were hauled in advance and stored on the grade a long way ahead of the mixer.

The mixer used was a six-sack Koehring paver and feeding it by wheelbarrows was out of the question. The plan adopted by the contractor was that of using three-wheel trucks, each carrying a single hand-dump batch box, which were shuttled back and forth between the mixer and the stock piles.

The pebbles used as coarse aggregate were loaded into elevated hoppers by means of a Mogul loader made by the Spears Wells Machinery Company, which consisted of a portable bucket elevator mounted on continuous treads and fed by a toothed ribbon conveyor. In obtaining a load, a truck stopped under the elevated hopper and received from it by gravity pebbles filling the batch box up to a predetermined point; the truck then proceeded to the nearest sand pile where the sand was shovelled in by four men, sand being more easily handled by hand than pebbles. The truck then proceeded to the mixer and dumped the load into the skip, where cement was added. The trucks did not turn around but backed from the mixer to the elevated hoppers.

Private Fire Protection Charges and Metering of Sprinkler System

Principles underlying the equity and law of charging for private service and decisions of various Public Service Commissions. Requiring meters on private fire services.

By John Simpson

The question of the authorization by a public service commission of a charge for private fire services connected with automatic sprinkler systems of industrial establishments is by no means a new one and has been considered by some of the courts and by most of the commissions of the various states. It has been generally held that a reasonable charge should be imposed for private fire service and in the great majority of cities and towns such charges are authorized.

Private fire protection is usually required either by special municipal ordinance or by requirements of fire underwriters, who make differential rates dependent upon the various risks of the insured. Private fire protection lowers the risk; and to secure the lesser risk and lower insurance rates, underwriters desire the largest practicable size of service connection, consumers desire the lowest possible rates (both insurance and water), and the water utilities in general desire to secure the greatest possible revenue from the service. Before the period of regulation of rates, this resulted in a three-cornered controversy, ending in each particular case in a trade and a special contract. Lincoln v. Lincoln Water & Light Co., 4 Ill. P. U. C. R. 113 (1916).

The owner of a two-story garage equipped with a sprinkling system complained to the Pennsylvania Public Service Commission of the water company's metered and ready to serve charges therefor, contending that the rate for private fire protection service, with adequate pipe connection, should not exceed the company's fire hydrant rate. The company claimed that it was not selling private fire protection, but, with the exception of the fire hydrant rate, sold water only through metered connections at rates alike to all consumers for all purposes. The principal question involved in the case was whether or not a water company should have a special and definite rate for private fire protection service, especially that required in the use of sprinkling or other automatic devices in the interior of buildings. The Commission sustained the complaint, Wood v. Springfield Consolidated Water Co., July 26, 1921, and directed the water company to submit to the Commission for its approval a special or definite rate covering private fire protection service rendered by the installation of sprinklers or other automatic devices.

In the course of its opinion the Commission pointed out that there is very wide divergence in the practice of water utilities throughout the country in dealing with private fire protection services. Some utilities make no rates applicable to interior automatic devices other than those which apply to the supply of water for domestic consumption; others have rates comparable in varying degrees to public fire protection rates; while in still other instances municipal utilities have sought to encourage the use of private fire protection services by making no charge therefor.

It is quite apparent that for water utilities adequately to supply private fire protection services, in addition to that which is required in the public service, they should have a fair measure of return. There is, no doubt, great difficulty in satisfactorily segregating charges of this kind. But it would appear to be a fair principle, where a consumer has, for example, installed throughout a two-story garage building a sprinkling system designed to be connected with the utility's water main, to have a charge for private fire protection service that would represent a middle ground between the yearly rate for a fire hydrant, and the readiness-to-serve domestic consumption rate. A special rate based on such a principle would more equitably divide benefits between the public, the utility, and the user of private fire protection service, than the one based upon either extreme of charge.

Some water utilities have made the following provision for private fire protection service:

1. Installation of separate service lines, with detector meters to prevent waste or theft of water.

2. Special readiness-to-serve charges based upon size of meter connection, considerably reduced from the charges imposed for domestic consumption purposes, due to infrequent consumption of water.

3. The usual rates for water actually consumed.

The Pennsylvania Commission considers that the utilities which have adopted such rate principles have justly and equitably met the situation. They have protected themselves against water losses; have provided themselves with fair return for steadily service and actual water consumption, and have not restricted the benefits which both private consumers and the public have obtained from the installation of special

fire protection devices in factories, stores, theatres, hotels and other buildings of general business nature.

The Pennsylvania Commission considers that, while it is true that the installation of automatic fire protection devices is of primary benefit to the properties immediately concerned, there is no doubt that such private fire protection services afford a considerable degree of public benefit in limiting the extent of destructive fires. This is attested by lower insurance rates, and the laws of Pennsylvania themselves take cognizance of the fact that private fire protection devices may considerably reduce hazard to life and property. It therefore follows that they are valuable supplements to the ordinary means of public fire protection.

In 1901 it was held, Loveman v. City Water Co., 7 Tenn. Ch. App. 596, that a water company which supplies the pressure and water for an automatic sprinkler for a private corporation and stands ready to supply the necessary water in case of fire through a four-inch pipe performs a service in thus standing ready which is not included in its contract with the city to supply water for fire protection, and has the right to make a reasonable charge against the corporation. There was no attempt to charge for the water that was in the consumer's tank and in the pipes of its automatic system; that had already been paid for, having gone through the meter.

In the case of the application of the water department of the city of Evansville to the Indiana Public Service Commission (August 5, 1922) for authority to establish a charge for automatic fire sprinkler service, the Evansville Chamber of Commerce opposed the grant on the grounds that the installation of such a system redounds to the advantage of the water utility and of the community generally because its operation tends to extinguish fires at their inception and thus obviates the necessity of pumping large quantities of water, and that very little, if any, additional expense, is incurred by the utility in having its mains connected with such automatic sprinkler systems.

The evidence before the Commission, as stated in their opinion, showed that an expense does fall upon the utility in regard to furnishing connections for private fire protection systems, not even taking into consideration the fact that the utility must stand ready to furnish the amount of water which would be required by such systems in case of fire and must have the plant and distribution facilities necessary for this purpose. A good many of these systems have large tanks used in connection with them and these tanks require refilling and replenishing on account of losses of water by leakage and evaporation. The systems, too, are often drained and in such cases replenishment is necessary. A system of inspection must be maintained by the water works department in order to avoid waste of water through leaks or taps in sprinkler systems, and occasionally a loss of water occurs through sprinkler leakage. The evidence showed that there were 76 automatic fire sprinkler systems attached to the department's mains and that in all cases these connections were separate from the service through which the establishments maintaining them were served for their regular commercial needs.

The Commission authorized the department to make a reasonable annual charge for connection with private fire connection systems.

In North Coast Power Co. v. Pittock & Leadbetter Lumber Co., (1922) 118 Wash. 543, 204 Pac. 180, the sole question was whether the water company had the legal right to charge for fire protection service to a sawmill in addition to that charged through the meter for ordinary use of the mill. There was no question of the reasonableness of the rate charged. The system used here was a stand-pipe with hose connections. The pipe leading to and from the meter was a 6-inch pipe. The meter was a 3-inch one, around which was a by-pass which, in the event of fire, would permit the water to flow through the 6-inch pipe without passing through the 3-inch meter. To be able to furnish fire protection service it was necessary for the water company to have larger mains, higher pressure and greater reserve capacity than would be required for ordinary domestic use.

The court quoted and adopted the reasoning in Gordon & Ferguson v. Doran, 100 Minn. 343, 111 N. W. 272, where it was held that, in addition to the meter rate for ordinary use, an additional rate could be charged for the service rendered for fire protection. In that case the consumer maintained an automatic sprinkling system, connecting with the water mains of the city. It was there said:

"So long as water supplied for protection against fire is a purely public service, under the control and management of municipal authorities generally and under the fire department specifically, no direct charge to individuals is proper. When, however, a sprinkling connection is made with private premises, the situation is substantially different. These promises and the primary causes of catastrophe to the building and of the consequent possible use of disastrous quantities of water are primarily under the control, not of the public, but of the owner. A peculiar personal service is provided for his benefit, which is not enjoyed in common by the community in general, but is available only to a limited class of individuals. It does not advance the reasoning in this connection to split hairs between the 'use' and the 'consumption' of water. As a matter of good sense the property owner beneficially employs the water mains for his own purposes and to his own advantage, although he may not, except in case of fire, actually draw any water from the pipes. It is necessary and proper that for this he should pay. In effect he gets something of pecuniary value from another, which that other is not compelled to give except on the basis of contract."

The Minnesota case was also quoted with approval and the principle therein was applied by the Maine Public Utilities Commission in 1916.

when it held that a schedule of rates of the Portland Water District giving free private fire protection service to consumers of a minimum amount of water at the ordinary rate was unjustly discriminatory; that the district had no right to furnish this service free, and that the fact that private sprinklers are a community benefit, reducing the amount of water which would otherwise be used through the municipal fire apparatus, is a matter rather for the municipal authorities than for the water district. This finding was adhered to on a later hearing in 1917, where the question of private fire protection charges was thoroughly investigated, and charges fixed, consideration being given to the fact that the amount of water used by private fire installations might be much less than that used by the public fire protection system.

REQUIRING METERS

It is unreasonable to require a water company to stand ready to extinguish fires without some certain and sure compensation. The fire protection system is installed with the earnest hope that no water will be used. In the ordinary service the installation is wholly for consumption of water.

For this reason the Indiana Public Service Commission, Commercial Club. v. Terre Haute Waterworks Co., P. U. R. 1916 B. 180, was of opinion that all fire protection service should be metered, that the minimum charge should be 50 per cent. greater than for other services, and that such fire protection system patrons should pay for all water used at the usual rates.

The Wisconsin Commission, Manufacturers' Assoc. v. Kenosha, January 6, 1919, held that an ordinance requiring the installation of meters in connection with automatic sprinkler systems in compliance with an order of the Commission, was reasonable, the general experience of waterworks operators showing that "in any city where there exists a considerable number of unmetered connections between city water mains and private fire-protection pipe systems, there is likely to be some misuse and abuse of the service, and large quantities of city water used surreptitiously for general factory or industrial purposes, or wasted from neglected leaks or from both causes." The Commission regarded a meter as preferable to reliance on periodical inspection. "A meter is a mechanical inspector which is on duty day and night throughout the year, and one which not only detects the existence of a flow of water, but measures the amount. It is far more reliable and satisfactory, at least from the standpoint of the waterworks operator, and apparently less expensive." The Commission did not consider well-founded objections by property owners and insurance companies that the meters might become clogged and shut off the service altogether. This ruling was approved by the Pennsylvania Commission, Riverton Consolidated Water Co. Case, September 9, 1919.

The Wisconsin Commission in 1915 found the consensus of opinion among operators to be that a minimum charge for private fire protection is reasonable, based on the idea of the "readiness to serve" principle, varying with the size of the connection.

In the case of the Beloit Water, Gas & Electric Company the Commission considered that the water utility would be justified in metering all services installed for the purpose of such protection, not with the idea of charging for water used in case of fire, but for protection against surreptitious use, as close inspection and supervision had been found in many cases to be inadequate. The Commission found it difficult to establish a definite amount chargeable against private fire protection service, but assessed the charge according to the size of the service openings.

AMOUNT OF CHARGE

The Illinois Public Utilities Commission, in Lincoln v. Lincoln Water & Light Co., 4 Ill. P. U. C. R. 113, (1916) where consumers installed and owned their individual fire protection apparatus, made a service charge proportional to the size of the service pipe; where the consumer desired the company to install fire lines for him, it suggested that a combination of the service and footage rates might have to be adopted.

The Illinois Commission found it unexpedient to apply the rule adopted in the Lincoln Rate Case in the Pekin Waterworks Case (1917) because of the divers uses made of private fire protection in the city of Pekin, and resorted to a usage charge superimposed upon a service charge based primarily on the diameter of the service pipe. Many theoretical elements of the cost of this service were considered in fixing the rates, such as size of service, use of service in event

ices. And in establishing a private fire protection rate for the Northern Illinois Water Co. (1917) the same Commission took into consideration the size of the consumer's connection with the utility's distribution main, the number of outlets or sprinkler heads on the consumer's sprinkling line, and the number of private fire hydrants installed on the consumer's premises.

In the case of the city of Charleston and town of South Charleston where there were about seventeen consumers having a sprinkler system installed in their respective places of business for private fire protection, and three industrial consumers each with two hydrants for the same purpose, the evidence before the Commission did not show the amount of water used by these private systems, nor the burden they imposed upon the water company, so that it was difficult to estimate the amount of revenue this class of consumers should contribute. The West Virginia Public Service Commission, however, considered that as the property of these consumers was situated within the municipal limits, and therefore burdened with its proportionate expense of the public fire protection, a very great additional burden should not be placed upon this class of consumers. Western Virginia Water & Electric Co., P. U. R. 1920 D. 409.

Super-Power Electric Systems

Co-operation of power units in the South Atlantic and in California, with possibilities of such a system in the North Atlantic districts.

States in the past have shown a tendency to wish to preserve their natural advantages for their own citizens. New Jersey, for instance, has a law forbidding other states from obtaining water supplies from watersheds within her area. At present, New York State is endeavoring to preserve for herself, as against federal control, all the water power available within her boundaries. This is believed by some to be selfish and short-sighted and a position that ultimately will be found to be untenable.

In expressing this opinion, Guy E. Tripp, chairman of the Westinghouse Electric & Manufacturing Company, has called attention to the southern super-power system, through which power generated in North and South Carolina, Georgia, Alabama and Tennessee is all tied up into one system, and predicts that the time will come when all of the Atlantic seaboard will thus pool their power facilities and that in time the Atlantic Coast system and that now existing on the Pacific Coast will grow towards each other until the entire country will be embraced in one vast super-power system.

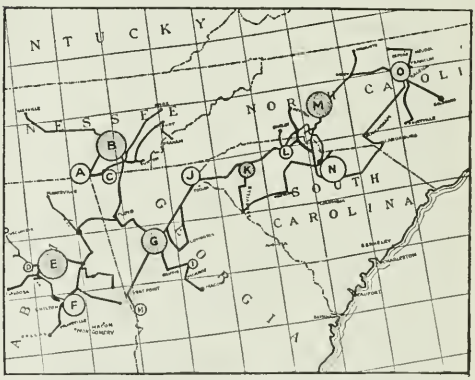
The southern super-power system to which he refers is shown by the accompanying illustration, in which the white circles indicate the principal generating stations, both hydraulic and steam; and the gray circles represent the chief centers from which the power is distributed to the near-by districts. The areas of the circles are proportional to the power generated or distributed at the several points. The heavy lines represent the connections between the several units. This system is over 600 miles long and covers the more important industrial areas of the states named, while extensions are already planned which will reach the remaining portions of these states and also Mississippi. The system is composed of seven independent but co-operating power companies.

All of the generating plants of the component companies pour all their energy into a common distributing network, which acts as a reservoir from which electricity can be drawn at any point for any purpose. This energy is obtained from hydro-electric plants, the exhaust gases of blast furnaces and refuse piles at coal mines. Water being the cheapest power, steam is not used until all of the available water power in all of the states is used to its limit.

An illustration of one of the advantages of this co-operation is shown by the experience last year of North and South Carolina. These states experienced a prolonged drought and consequent water shortage, and, as a result, the hydro-electric stations in those states were unable to supply the states' demands. Had there been no arrangement for obtaining power from outside the state, many factories would have been shut down, railway service curtailed and general inconvenience and loss experienced. As it was, Alabama had more power than was needed in that state and contributed its surplus to the Carolinas. Alabama, in her turn, profited by being able to sell her surplus energy which would otherwise have gone to waste. Some other year the tables will undoubtedly be turned and the Carolinas will contribute their surplus energy to meet Alabama's deficiency.

Another illustration is reported on the Pacific Coast, where the whole state of California is covered by a system of independent members under unified management. Still another is seen in the combination of several large water power developments which are tied together by the electrification system of the Chicago, Milwaukee & St. Paul Railroad, which is said to be one of the principal reasons for its success.

Mr. Tripp then refers to the Northeastern part of the country and proposes a super-power system which would include the undeveloped power of the St. Lawrence river in both Canada and the United States, the power of Niagara Falls both developed and proposed, with other power centers in New York State, Massachusetts, Northern New Jersey, Philadelphia, Pittsburgh, and other smaller power centers. In this section millions of horsepower in the form of water are being allowed to run to waste while enormous sums are spent unnecessarily for coal for generating steam power, and still large areas of the state are unsupplied with electricity. Should all the power in this district be utilized and combined, there would result a power system unsurpassable anywhere in the world. In 1921 there was generated in this district 14,000,000,000 k. w.



MAP OF SOUTHERN SUPER-POWER SYSTEM

The white circles (A, C, D, F, H, I, J, L, N) represent the amount of power generated at points indicated; the gray circles (B, E, G, K, M, O) represent amount of power distributed to consumers from the points indicated, which are the principal distributing centers of the system. All circles are drawn to scale. The total amount of power supplied by this system is over two billion killowatt-hours a year, most of which is generated by water power.

h., while the water power of Niagara Falls and River is 27,000,000,000, that of the St. Lawrence 21,000,000,000, and the other existing powers total almost as much.

Waterproofing Concrete Stand-Pipe at Waltham

After sixteen years of use, increasing leakage necessitated elaborate repairs, using asphalt, felt, mortar and brick.

By George C. Brehm*

In 1906 the City of Waltham, Mass., constructed a reinforced concrete standpipe reservoir which was at that time the largest of its type in the country. The construction was of 1-2-4 concrete, the wall being reinforced with steel bars arranged in three rows up to twenty feet, two rows for the next seventeen feet and one row to the top, same being designed to keep the tensile stress within a 12,000 pound limit The roof consists of a concrete slab three inches thick supported by steel trusses radiating from a central concrete-covered pipe column, which served also as an overflow.

This standpipe is one hundred feet in diameter, forty-three feet high, with a capacity of a little over two million gallons of water, and is situated in the western end of the city on a ledge knoll. The original cost of this reservoir was about $26,000. The specifications for its construction were prepared with the greatest care. The engineers in charge did everything possible to produce a concrete which would be absolutely water-tight. Every precaution known at the time was taken to insure against the slightest seepage. After extensive experiments, Medusa compound and lime were added to the concrete in prearranged quantities. After the concrete had cured and the forms been removed, all joints were thoroughly cleaned and scraped and the whole inside surface given an extensive brush coat of mortar treated with these same compounds. (This standpipe was described in Municipal Journal for Jan. 2, 1907, and July 22, 1915. Editor).

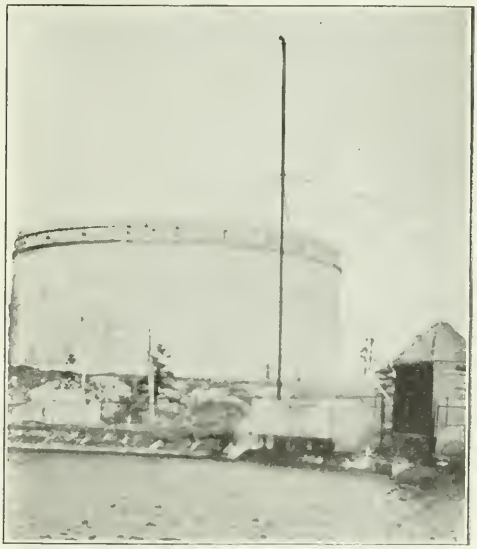
In spite of all these precautions at the time of construction, leakage developed after a few years. In 1914, an ill-advised attempt was made at water-proofing by the application of a coat of pitch to the inside wall. This amounted to very little and another attempt was made shortly after by the application of cement, using a cement gun on the outside. Neither of these methods proved satisfactory, the seepage continued and successive frost action caused several large areas of the outside wall to disintegrate, the surface breaking in several places to such an extent that the reinforcing rods became slightly exposed at several spots.

*City engineer and director of public works, Waltham, Mass.

The water level of the standpipe when full is 256 feet above sea level. The city also has, adjacent to this standpipe, an open reserve reservoir with a capacity of six million gallons, the elevation being, when filled, approximately 205 feet above sea level. Between the year 1914, when the first attempts were made at waterproofing, and the present, the water system of this city has been extended to the developed outlying sections of the city, and at the present time requires on elevation of not less than 235 feet at all times for the convenience and safety of the whole city, especially the outlying sections.

The problem therefore confronting the city officials was to keep sufficient pressure to insure the convenience and safety of the whole city with their water supply while a thorough and final job of waterproofing was being done. It was obvious that the reserve reservoir at an elevation of 205 feet would not insure the supply.

The writer, who is director of public works, conceived the idea of erecting an eight-inch pipe in the vicinity of this standpipe, tapping the twenty-four inch feeding main with a 24″ x 8″ Smith tapping sleeve and valve, and by keeping the pumps at the nearby pumping station continuously operating, maintaining a head of water at all times at sufficient height to insure the city supply. A wrought iron eight-inch pipe was therefore erected to a height of 276 feet above sea level, same being guyed for safety as shown in the accompanying photographs. The pumps at the pumping stations were then set in operation, the pumping continued for twenty-four hours per day, the speed of the pumps being



OPEN RESERVOIR IN FOREGROUND, CONCRETE STANDPIPE IN BACKGROUND, TEMPORARY STANDPIPE BETWEEN THE TWO.

VIEW OF TEMPORARY STANDPIPE FROM TOP OF CONCRETE STANDPIPE

regulated to maintain enough pressure to drive the water to the top of this pipe sufficiently to have a slight overflow, the pipe being erected so as to allow this overflow spill to drop into the open reservoir.

The contract for waterproofing having been previously let and all details arranged, the large concrete standpipe was emptied, the inside wall thoroughly cleaned and dried, a number of salamanders being used to hasten the drying. After the walls had thoroughly dried, the waterproofing was started. It consisted, first, of a mop coat of Texaco No. 56 waterproofing material applied hot to the inside face of the wall. Immediately outside of this was applied a coat of waterproofing felt, the surface of the same being mopped with another coat of Texaco No. 56 waterproofing asphalt. This operation was repeated for five layers, the outside layer, however, being of six-ounce saturated duck fabric, and the outside surface of this finally mopped with the waterproofing asphalt. Immediately following this, a four-inch brick core was constructed from the floor to the top of the wall, great care being taken to obtain a one-half-inch mortar course between the outside asphalt course and the inside face of the brick wall. All of this work, of course, was started at the bottom and built up the entire inside circumference of the wall in six-foot sections.

The work was started November 20th, 1922, in spite of the most inclement weather and was finally completed and the reservoir refilled on December 23rd. As the stagings on the side of the wall were taken down, the whole inside face of the brick core was thoroughly cleaned by washing.

It is of interest to note that all the materials used in this work had to be hauled to the very inaccessible point where the reservoir is located, raised to the top and lowered through a 4 x 4-foot hole made in the concrete roof. Instead of the usual steam or electric power for hoisting, the contractor used a medium sized tractor, rigging a boom derrick on the top of the reservoir, fastening the hoisting cable to the front of the tractor, which moved up and down the country road at the side of the standpipe, raising and lowering all the materials in a hoisting pan in this manner.

Simpson Brothers of Boston were the general contractors on the work, W. A. Murtfeldt Company of Boston, sub-contractor on the waterproofing, and M. F. Stankard of Waltham, subcontractor on the brick work. The engineer's estimate on the whole work was $16,500, while the low bid of the contractor for the whole work was $16,543. The materials used in the work were about as follows:

15 tons of Texaco No. 56 waterproofing asphalt, 150 rolls of felt, 550 bags of cement, 100 bags of lime, and 85,000 brick.

METHOD OF HOISTING WATERPROOFING MATERIAL INTO CONCRETE STANDPIPE

The reservoir has been refilled and every indication shows that a complete waterproofing job has been obtained and that no further seepage is possible. As soon as the weather permits, the city officials intend to touch up the outside wall with mortar where disintegration has taken place and will probably give the whole outside wall a thin stucco finish for the sake of appearance and protection. The reservoir is pronounced by experts now to be absolutely waterproof for all time.

Depth and Grading of Percolating Filters*

English and American views on the subject compared and conclusions from experiments carried on at Dorking, England.

The problem for solution in discussing the subject of percolating filters is how to get the best result from a given quantity of material; how should the material be arranged—in deep or in shallow filters? There were three possible views, all of which had their advocates.

(a) That the surface area should be as large as possible, i. e., the filters should be as shallow as possible down to a minimum of, say 2 ft. 6 in. This view was represented by the numerous fine filters of shallow depth found in Staffordshire and recommended strongly by Dr. Reid.

(b) That within reasonable limits the purification was governed by the cubic capacity, and was unaltered by the arrangement. This appeared to be the view taken by the Royal Commission on Sewage Disposal.

(c) The view held by the Massachusetts authorities that the most satisfactory depth of a filter was about 10 ft. or more, and a filter of this depth was capable of purifying a greater volume per cubic yard than was a shallower one.

Summarizing the works of Dr. Reid on fine filters, it was shown that in the results quoted purification was practically complete at a depth of 1ft., and that the remaining depth was practically without influence on the quality of the effluent.

It was to be noted that these results were obtained in a very weak septic tank effluent, oxygen absorbed 2.18, and suspended solids 3.8, and that at the rate of 200 gallons per square yard purification was to all intents and purposes complete at 1 ft. (cf. nitrates, oxygen absorbed, and transparency 24 in. over). Whether the lower part of the filter could be utilized by increasing the dose or in the case of a stronger sewage was not determined by those experiments. With a fine-grade filter it did not appear practicable to increase the dose sufficiently to utilize the lower part of the filter.

In quoting the work of the Royal Commission it was shown that in general with coarse filters the greater the depth the greater the purity of effluent when dosed at the same rate per square yard. Work done on these lines at Accrington (1897), Salford (1900), and Horfield was quoted.

These experiments, however, did not show whether it was better to arrange a given quantity of material in the form of a deep or of a shallow percolating filter, and the Royal Commission proceeded to investigate this at Horfield and Ilford. At Horfield they used two coarse clinker filters dosed at the same rate per cubic yard, and came to the conclusion that there was little to choose between the effluents; if anything, the deep filter effluent was slightly better, probably owing to irregularities of distribution being less pronounced with a deep filter.

Similiar experiments were carried out at Dorking, and they finally conclude:

(1) "That with the same dose per square yard the deeper the filter the better the effluent. This holds both for fine and coarse material, assuming good distribution and aeration.

(2) "For practical purposes and assuming good distribution, the same purification will be obtained from a given quantity of coarse material, whether it is arranged in the form of a deep or of a shallow percolating filter, if the volume of sewage liquid treated per cubic yard be the same in each case.

"Thus a filter 3 ft. deep, worked at the rate of x gallons per square yard per day, would give similiar results to a filter 6 ft. deep, worked at the rate of 2x gallons per square yard.

"In the absence of clogging, the balance would be slightly in favor of the deep filter, because the greater the depth the more errors of distibution would be neutalized. There must always be a limit of shallowness (say 3 ft.) beyond which it would be unwise to go, for however good the distribution might be, if a coarse filter were constructed very shallow, a considerable proportion of the sewage would pass through by 'short cuts.'

(3) "With regard to filters of fine material, if the liquid to be purified were absolutely free from suspended and colloidal solids, and if thorough aeration could be maintained, the statement just made for filters of coarse material might possibly hold good for filters of fine material also. In practice, however, these conditions can scarcely be maintained with large rates of flow, and we think that the greatest efficiency can be got out of a given quantity of fine material by arranging it in the form of a shallow filter rather than of a deep filter. But we are not in a position to make an exact quantitative statement as to the difference in efficiency of the two forms.

"It is probable that for the treatment of a strong sewage liquor the filter should not be quite so shallow as for a weak liquor, but the point has not been fully worked out.

(4) "The extent of the purification effected by a percolating filter varies with the average length of time taken by the sewage liquor to pass

*Notes of a paper delivered before the Yorkshire District of the Association of Managers of Sewage Disposal Works, Leeds, England, by W. J. Reid, deputy chief inspector to the West Riding Rivers Board.

through the filtering material, assuming that the proper aeration of the filter is maintained."

The experiments carried out at the Lawrence Experimental Station, Massachusetts, were then detailed.

The experiments were commenced in 1913, and an attempt was made to determine the rate at which four filters of different depths must be operated to obtain effluents of equal quality. The filters were of ¾ in. to 1½ in. broken stone, and were respectively 4 ft., 6 ft., 8 ft. and 10 ft. deep. They were fed with a settled sewage at such a rate that the nitrates in the effluent remained at about 1.5 parts in each case.

It will be noted that in this case the problem is attacked from a different standpoint; that is, instead of comparing the effluents produced at the same rates per cubic yard (or square yard) they manipulated the dosing until the effluents were the same, and then compared the rates of working.

The following table shows the results during 1914 and 1915, and the rates of dosing in British gallons:

	1914.			
Filter	A	B	C	D
Depth, feet	4	6	8	10
Gallons—				
Sq. yd.	57	101	310	642
Cu. yd.	43	50	116	192
N. F. & S.	1.86	1.29	1.36	1.73
N. Alb.	.30	.29	.37	.39
Cl.	13.2	13.3	13.0	13.5
N'ic.	1.63	1.81	1.66	1.76
N'ous.	.006	.013	.013	.008
Ox. Abs.	1.89	1.79	2.17	2.38
Stab.	85	95	97	86
	1915.			
Filter	A	B	C	D
Depth, feet	4	6	8	10
Gallons—				
Sq. yd.	80	138	304	605
Cu. yd.	60	69	114	181
N. F. & S.	1.23	1.22	1.18	1.12
N. Alb.	.24	.21	.27	.21
Cl.	9.1	9.3	9.5	8.6
N'ic.	1.03	1.07	1.00	1.26
N'ous.	.005	.016	.007	.003
Ox. Abs	1.89	1.62	1.84	1.80

The increase in rate of dose per cubic yard with the depth is remarkable.

It was stated that the Massachusetts authorities explained these results in terms of the hydraulic flow through the filter, showing by means of salt solutions that the times of appearance through the filters of a mixture of half salt solution and half sewage were 12, 18, 48 and 105 minutes respectively for the 4 ft., 6 ft., 8 ft., and 10 ft. filters, and that thus the time of contact for the deeper filter was longer in a much greater ratio than the various depths.

Further, they showed that when the rates were increased to give an equal time of contact, then the rates were also those which gave equal analytical results when dosed with sewage.

Mr. Reid pointed out that the results obtained were not in agreement with those obtained in England, and urged that experiments should be carried out on the Massachusetts lines, which method does not appear to have been used in that country.

Hudson River Toll Bridge

Work began in April on the bridge spanning the Hudson River between Bear Mountain and Anthony's Nose, the river span of which is said to be longer than that of any existing bridge, or 1,632 feet. The total length of the bridge between abutments will be 2,258 feet. The roadway will be 185 feet above the river and the two main towers will rise to a height of 350 feet above the foundations. The bridge will have a 38-foot roadway and a 5-foot sidewalk on each side. It will be suspended from two 17-inch cables, while the roadway will be supported directly by two stiffening trusses 30 feet deep. The bridge is estimated to have a capacity of more than 5,000 motor cars an hour. Wilson Fitch Smith is the chief engineer of the Bear Mountain Hudson River Bridge Company. Contracts for the construction were let in March and work on the approaches began in April and the steel companies have begun to fabricate the steel, of which more than 12,500 tons will be used.

Gasoline Tax in Tennessee

A tax levying two cents per gallon on gasoline and distillate sold in the State was passed and enacted by the Tennessee Legislature, March 15th, 1923. This tax is estimated to bring revenue of about one and one-half million dollars per year to be used for construction and maintenance of the State highway system. The State Legislature, after passing this bill, repealed the road tax which levied five cents per $100 on all property assessed by the State, which had been in force about four years, bringing in a revenue of approximately $700,000 per year.

Economy in Using Bulk Cement

In building 17 miles of concrete pavement in Black Hawk County, Iowa, the Northern States Contracting Company of St. Paul obtained its cement in bulk. The cement arrived in box cars which were spotted beside the platform at the cement warehouse. Four men shovelled the cement directly from the cars into two-wheel steel carts, which were wheeled by one man to a platform scale and weighed to correct any error in quantity. Batch trucks carrying aggregates for one 10-sack batch stopped at this platform, a steel plate hinged to the edge of the platform was dropped over the edge of the truck body to form a runway, and the 2-wheel carts dumped their loads of cement on top of the sand and stone. One of the dumpers then covered the cement with part of the sand in the truck so that it would not blow away while making the run to the mixer. No attempt was made to store the bulk cement, but the warehouse was kept filled with sack cement for emergencies, which occurred only occasionally.

Bulk cement was purchased for 5c. a barrel less than cement in the sacks, there were no sacks to check, count, bundle up and return and no money tied up in unreturned sacks. It was found that no more men were required than would have been needed for sack cement, and the trucks were loaded more quickly than if sacks had to be dumped onto the aggregate.

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Water Connections and Paved Streets

As a general proposition, the fire underwriters and the majority of waterworks engineers do not recommend street mains for water supplies of less than 6 inches diameter, and yet the use of 2-inch pipe, we believe, is more than justified under certain conditions.

A number of cities have found so objectionable the digging-up of improved pavements for the laying of service connections that they require the water company or water department to carry connections to the curb opposite every lot, whether occupied or not, prior to the laying of a permanent pavement on the street in question. There are objections to this besides that of the idle capital represented by unused services, in addition to which there is no certainty that the pavement will not have to be dug up for repairing leaks in the services later on. If the main be laid between the curb and the property line, half of the services are removed from the roadway altogether, but the other half have to be carried entirely across it.

The chief reason for requiring a 6-inch main is to secure adequate supply to the fire hydrants. A 2-inch pipe would generally suffice to supply the domestic consumption of all of the houses on a single block. Why not, therefore, lay a 6-inch main inside the curb on one side of the street—just outside the property line would give the minimum length of service connections on this side and generally be further from tree roots than any other part of the sidewalk space—and carry a 2-inch line in a similar position on the other side of the street? The cost of the 2-inch line probably would not exceed that of carrying a 5/8-inch service line from the main on the other side of the street across to the location of the 2-inch line for each of the building lots on that side of the street; but even if the first cost should be somewhat greater, the cost of maintaining a service under the pavement is eliminated and all of the objectionable features connected with either laying dead services prior to paving the street, or cutting through the street for laying services as needed.

The above is not an entirely new idea, although it does not seem to have been adopted by many cities, but is suggested by a news item stating that Higginsville, Missouri, has adopted for one of its streets a plan somewhat similar, the construction in this city consisting of laying 2-in. pipe across the street at intervals of 300 feet to a point just behind the curb, where a 2-inch cross is placed; to which cross, by means of a tapped plug, house connections can be made.

Buy Construction Machinery Now

In a paper before the annual Michigan conference on highway engineering in February of this year, W. S. Cummings, highway engineer of Monroe county, stated a problem that is facing hundreds of other highway engineers when he said: "The problem is not altogether what shall we pay the men, but where shall we get them?

This condition among others has led us to do considerable experimental work in developing devices to suit our purpose." He then described equipment of various kinds which had been purchased, adapted or designed to save labor in various processes of road construction and maintenance.

During the past twelve months construction costs have increased 30%, that of several of the materials showing an increase of 50% and more. More startling and more serious, however, is the labor situation. Wages for labor in most sections of the country are from 50% to 100% higher than they were early in 1922 and, what is even more serious, the supply will apparently prove to be far from adequate. Already, although the season has barely started, contractors are finding difficulty in securing men at any price and highway construction has already been greatly interfered with in some sections by the labor scarcity.

A year ago the woods were full of would-be highway contractors, many of them apparently ignorant of the basic principles of estimating contract costs, and bids were cut to the point where profits reached or passed the vanishing point. Most of these have learned their lesson and, even with conditions the same as a year ago, bids would probably be higher. When we add to this the increase of from 30% to 50% and even more in the cost of materials and labor, and the probable scarcity of the latter with the increase which this will make in the cost of doing work, public works officials must be prepared for higher prices this year. Most of them are so prepared and it is probable that the amount done this year will not be greatly curtailed by such increase in prices as is reasonably accountable for by increased costs and wages.

Contractors, however, even though they may obtain fair prices sufficient to cover advance in costs, will still be confronted with the labor situation. To install an expensive plant, assemble a force of high-grade foremen and superintendents and then have the whole work halted by inability to obtain or retain sufficient labor to keep the equipment busy means loss in overhead and in interest and depreciation on plant that may easily eat up any prospective profits in a short time.

The high wages and scarcity and general unsatisfactoriness of labor during the past five or six years has resulted in the rapid development of mechanical appliances by which it is possible to replace a considerable percentage of the men formerly employed in highway construction. Given jobs of any considerable magnitude, mechanical graders and loaders, ditching machines, etc., will replace practically all pick-and-shovel men, one truck will replace a dozen mules with their drivers, the necessary bins and equipment for batch trucking of concrete aggregate will save all of the shovel and wheelbarrow gang ahead of the concrete mixer, while a finishing machine with one mechanic will replace several laborers behind the mixer.

The day is past when highways can be built successfully by a contractor whose only ability is getting work out of a gang of huskies. More than ever the highway contractor of the present and the future must be a man of business ability who can plan for each job that combination of equipment and methods requiring the minimum number of men to operate them that will most satisfactorily and economically produce the necessary results.

If anything approaching the amount of highway and other public work contemplated for this year is to be put through, contractors generally must provide themselves with the necessary equipment, and it seems certain that there will be an unprecedented demand for all kinds of labor-saving equipment and devices. We believe, therefore, that the contractor who is to be successful this year will supply himself with the necessary equipment in abundance, and will get it at once. Few of the manufacturers carry any large supply of equipment from year to year, and unless orders are placed at once, it is probable that deliveries cannot be made before the construction season is far advanced.

The suggestion in this to public works officials would appear to be that those who let their contracts earliest stand the most and perhaps the only chance of having them completed this year; and those will have the greatest advantage who let the work in contracts sufficiently large to warrant the contractors in providing themselves with the kind and amount of equipment necessary to meet successfully the anticipated scarcity of labor.

Public Health Boards and Finances

In an address before the Boston Society of Civil Engineers, M. N. Baker recently called attention to the demonstrated capacity of engineers to serve as health officers, citing Hiram F. Mills and Frederick P. Stearns in Massachusetts and the employment of engineers by most of the state and many local health departments.

One characteristic which the engineer in general possess much more abundantly than the physician is the ability to realize the limitations imposed by a fixed appropriation, discern the point of diminishing returns in each feature of a health program, and so apportion the expenditures among the several lines of endeavor as to obtain the maximum combined result in the form of public health. Judgment of this kind, available in its health officer, is of great value to a local health board, and should be appreciated and availed of. In this and in most other ideas conveyed by Mr. Baker in this address we agree heartily; but with one we must take issue.

"I hope I shall live to see the time," said he, "When our state health departments will not approve plans for water supply or sewage disposal until their engineers and other specialists have taken full cognizance of the entire sanitary and health needs of the municipality in question with a view to determining whether the

expenditure necessitated by the plans for approval would produce more and better results in terms of lives saved if the money was used for some other purpose. In other words, if state authorities are to be dictators over one or two classes of outlays for health and sanitation, let them cover the entire field."

In our opinion, the state board of health should NOT be a dictator, although some of them have assumed to be. We do not consider that how much a city pays for a water or sewerage system is any of its business, but only whether such system contributes to the health of the people. If it believes that a system could be obtained at less cost which would give equal health service, the board can and probably should so advise the city, but it should have no power to dictate in the matter. Its only function is to minister to the health of the community, not to its finances; to require the removal of conditions that threaten the health of the people of the state, but not to dictate the method to be employed or to prevent the trial of one that offers reasonable chances of success.

As indicating the possibilities of such dictation, cases can be cited where a state health board has prevented communities from installing water purification and sewage treatment plants which have been recommended by engineers with vastly wider experience and higher reputation than any one connected with the board as either member or advisor. If this power were general throughout the states and were exercised as at least two state boards have exercised it, progress in these branches of sanitary engineering would cease or could progress only along the lines that happened to be favored, for one reason or another, by those whom politics or other favoritism had placed for the time being at the head of an ultra-paternalistic health department.

After writing the above we find the same idea expressed by the editor of an English paper, "Municipal Engineering and the Sanitary Record," who, in discussing this part of Mr. Baker's paper says:

"We question his proposition that State health officials should have power to hold up plans of local water supply or for works of sewage disposal until the Department's engineers or other specialists are satisfied that the money could not be spent to better advantage on something else for the purpose of life. Some sort of inquiry would be necessary, local people would have to be heard, and a mass of discrepant material would confront the investigator. Would progress be possible if an official were delegated to sit in judgment upon such a mixture of local subjects, bias, and controversies?"

Furnishing Equipment for Contractors

In connection with the letting of contracts for constructing certain forest highways in New Mexico, the Bureau of Public Roads informs prospective bidders that it has on hand equipment useful for doing this work which can be used by contractors at rentals which are specified; and that in comparing the competitive bids, that one will be held to be in general the most favorable which requires the least cash payment by the Government—that is, the sums used in comparing the bids will be those obtained by deducting from the total bid the rental for the equipment which the contractor agrees to use.

This would appear to give a decided advantage to the contractor who was not provided with equipment of his own and might at first thought seem to open the way to giving the contracts to contractors of such little experience that they had not provided themselves with equipment suitable for the work.

In a letter to PUBLIC WORKS explaining the matter, however, E. S. Wheeler, district engineer of the Bureau of Public Roads for Arizona and New Mexico, states that conditions there are far different from those in the eastern part of the United States where there are numerous contracting concerns properly equipped for all kinds of construction. In the undeveloped southwest this is not the case and the Bureau feels that it is a duty to educate the contractors in the use of adequate equipment and that renting equipment to them is one of the means to this end. Moreover, contractors bidding on this work are not necessarily those who have never done any work of this kind before, although it is quite possible that such as they have done may have been of smaller magnitude. In addition, the district office exercises the prerogative of investigating the experience and ability of the contractor and his financial standing before recommendation for award is submitted.

Of the surplus war material which was turned over to the Bureau of Public Roads, 90% is distributed among the various state highway departments, but 10% is retained by the Bureau. It is considered to be the economical, efficient and business-like thing to save as much money to the Government as possible through the use of such equipment on day-labor projects or by renting it to contractors on work done on projects under the direction of the Bureau. The equipment is furnished to the contractors on a rental basis at prices that have been predetermined, and the Bureau also sells to the contractors explosives at a price that will reimburse the Government in a certain percentage of the original cost plus freight and handling. This price is made sufficiently reasonable to be attractive and to assist the Government in disposing of a large amount of explosives, but is not done for the purpose of competing with the local market.

Using Local Road Material

That part of Florida in the vicinity of Port St. Joseph is said to be entirely devoid of rock or gravel, or any other material ordinarily considered suitable for road surfacing. Recently, however, highways have been built of material found in the locality that have given good satisfaction. Even within the city itself a street has been surfaced with this material and is now nine years old without having depreciated materially.

The material used is a sediment from the bay

consisting of particles of shell, sea sand and a clay mud which, when dried, acts as an excellent cement. The cost of this road is said to average about $6,000 a mile. To ship any material such as stone or rock from other sections of the country would bring the cost of road construction to several times this amount.

In using this material a large steam shovel was run out into the shallow water and dug up the material from the bottom of the bay, which was then spread over the roadway and graded and permitted to dry thoroughly before being opened to traffic. The cementing mud is said to furnish a practically waterproof surface.

Water Works Statistics

Compiled from information furnished at our request by the superintendents of more than six hundred water works plants. Mains laid in 1922. Methods employed for purifying water.

In this issue we publish figures and other information compiled from questionnaires returned to us by the superintendents of more than 600 waterworks plants throughout the country. This compilation is arranged in two tables, one dealing with the street mains laid in the year 1922 and the other with methods of purification employed by the different waterworks plants.

The answers from which the first table was compiled were given in reply to the following questions: "What length did you lay in 1922 of castiron mains under 6 inches diameter?" "Of 6-inch, 8-inch, 10-inch and 12-inch diameter?" "Larger than 12-inch diameter?" "How much of this was centrifugal pipe?" "How much was 'universal'?" "How much with pre-made joints?" "How much steel main did you lay in 1922, 12-inch diameter or smaller?" "How much larger than 12-inch?" Information concerning steel pipe and kinds of pipe other than ordinary hub and spigot were comparatively few and are given in the last column headed "Other Kinds, and Remarks."

Apparently only three of the cities replying had used centrifugal pipe — Phoenix, Arizona; Cedar Rapids, Iowa, and Perry, Oklahoma. Mr. Blomquist, of Cedar Rapids, wrote that he got one car (2,000 feet) of it from the U. S. Cast Iron Pipe Company for trials last fall, and laid about 1,200 feet of it last year. "Our impression of it is that they still have it too brittle for successful use. A way of overcoming this may be found by changing the composition of iron used."

The water purification data compiled were given in reply to these questions: "In treating your water do you use sedimentation basins?" "Filters?" "What kind of filters?" "Do you chlorinate it?" "Do you soften it?" "Do you treat it in any other way?" "What was the cost of the purification plant?" "How many gallons was treated last year?" "What was the cost last year for labor at purification plant?" "What the cost of chemicals?" "What the cost of repairs?" "What the cost of power?" "What other cost of purification?" Apparently some of those replying interpreted the question concerning the cost of repairs to apply to the entire systems and not only to the water purification plant, and the cost of power to apply to the pumping as well as to water purification. We have nothing but the figures themselves as a basis for this assumption, and give the replies as they were returned on the questionnaire. Any explanations or supplementary information given in connection with the replies which could not conveniently be placed in the tables are given in the footnotes.

We have summarized the information concerning the methods of treatment employed by the various cities with the following results: Of all the plants reporting, 26.6% treat the water in sedimentation basins; 26.9% treat it in filters, 1.8% of these being pressure filters, 2.4% slow sand filters and 22.6% rapid sand filters. Five cities reported infiltration galleries, and two reported natural filters (sand or gravel in place). 41.6% of the plants reported chlorinating the water, four of them treating part of the water only in this way and nine of them only part of the time. Twenty-four plants reported softening the water, twelve used copper sulphate, four aerated, one used an iron removal process and one the excess lime process.

Quite a number of the cities which do not treat the water explained that it was obtained from sources where pollution was impossible, generally from deep wells. The names of these cities are not given in the table, as this would have increased the table to an excessive length.

A number of the plants are new and could furnish no operating data. These include Jasper, Ala., pressure filters installed in February; Blytheville, Ark., and Bristol, Conn. each just installing a chlorine plant; Orlando, Fla., will have a filter and chlorine plant ready in June; Johnson City, Ill., installed a rapid filter and chlorine plant last fall; Paris, Ill., has just started a rapid sand filter; Manhattan, Kans., has just completed a rapid sand, softening, iron removal, and chlorine plant; Cambridge, Mass., will have filters operating by June; Bay City, Mich., has a chlorine plant under construction; Benton Harbor, Mich., has just started a sand filter, chlorinating and softening plant; Yazoo City, Miss., has just installed a chlorinating plant, and Ambler, Penn., is installing one; Delaware, O., has just put in operation a sand filter, chlorinating and softening plant; Kittanning, Penn., put a mechanical filter and chlorinating plant in operation in January; North East, Penn., is installing a rapid sand filter and chlorinating plant; and Navasota, Tex., installed a chlorinating plant in April.

STREET MAINS LAID IN 1922

City	Plant municipal (M) or private (P)	Cast Iron Mains: Under 6″	6″, 8″, 10″ & 12″	Over 12″	Other kinds, and remarks
Alabama:					Reports from 5 cities
Athens	M	.....	.....	.....	300′ steel mains 12″ or smaller
Jasper	P	1,400	3,500	.....	.....
Opelika	M	2,000	1,500	.....	400′ with pre-made joints
Arizona:					Reports from 4 cities
Douglas	M	17,500	.....	.....	.....
Phoenix	M	.....	1,546	.....	.....
Prescott	M	659	2,062	.....	.....
Arkansas:					Reports from 8 cities
Batesville	M	.....	750	.....	.....
Blytheville	P	1,000	.....	.....	All Universal. 300′ steel mains 12″ or smaller
Harrison	M	.....	135	.....	All Universal
Pine Bluff	P	20,000	6,000	.....	.....
Russellville	P	4,100	.....	.....	.....
California:					Reports from 9 cities
Anaheim	M	3,822	14,181	.....	All Universal. 15,000′ steel mains 12″ or smaller
Glendale	M	115,935	56,514	.....	30,573′ steel mains 12″ or smaller
Monrovia	M	1,200	.....	.....	.....
Oxnard	M	680	2,100	.....	.....
Red Bluff	M	.....	300	.....	.....
South Pasadena	M	2,000	.....	.....	.....
Visalia	P	3,000	350	.....	6,000′ steel mains 12″ or smaller
Watsonville	M	.....	.....	.....	3,000′ steel mains 12″ or smaller
Colorado:					Reports from 6 cities
Colorado Springs	M	1,700	4,000	.....	.....
Ft. Morgan	M	.....	2,000	.....	.....
Las Animas	M	250	.....	.....	.....
Longmont	M	631	.....	.....	485′ steel mains larger than 12″
Montrose	M	11,000	.....	.....	16,000′ steel mains 12″ or smaller
Connecticut:					Reports from 9 cities
Ansonia	P	.....	315	.....	.....
Bridgeport	P	600	16,794	.....	.....
Bristol	M	.....	1,312	.....	2,871′ of w. i. smaller than 6″
New Britain	M	192	15,913	.....	180′ Universal
Putnam	M	360	966	.....	.....
Southington	M	10	871	.....	775′ Universal. 3,016′ of 2″ w. i. and steel mains
Torrington	P	528	702	.....	.....
Willimantic	—	.....	1,500	.....	.....
Delaware:					Reports from 2 cities
Dover	M	2 500	.....	.....	.....
Florida:					Reports from 7 cities
De Land	M	700	.....	.....	2 mi. steel mains small than 12″
Lakeland	—	10,000	.....	.....	2,500′ Universal. 1½ mi. 2″ gal. w. i.
Orlando	M	100	2,700	5,270	.....
Georgia:					Reports from 6 cities
Bainbridge	M	12	.....	.....	.....
Carrollton	M	2,300	38,300	.....	18,000′ with pre-made joints
Cordele	M	.....	900	.....	2,000 of 2″ steel mains
Griffin	M	320	2,200	.....	900′ centrifugal
La Grange	M	10,000	2,600	.....	2,600′ with pre-made joints
Idaho:					Reports from 8 cities
Blackfoot	M	.....	.....	.....	1,000′ steel main 12″ or smaller
Kellogg	P	.....	.....	.....	460′ steel mains 12″ or smaller
Montpeller	M	.....	.....	.....	800′ steel mains 12″ or smaller
Twin Falls	M	4,000	.....	.....	.....
Illinois:					Reports from 31 cities
Bloomington	M	13,200	2,600	.....	Smaller sizes Universal
Bushnell	M	2,500	.....	.....	.....
Centralia	M	.....	1,000	12,600	.....
Cicero	M	.....	7,800	.....	All Universal
Decatur	M	.....	9,000	.....	.....
Elmhurst	M	5,000	9,600	.....	.....
Evanston	M	354	17,160	.....	.....
Geneva	M	7,900	2,600	.....	.....
Johnston	M	56,910	47,178	.....	.....
Moline	M	.....	32,444	.....	.....
Oak Park	M	.....	1,328	.....	.....
Peoria	—	.....	7,231	.....	.....
Pinckneyville	M	.....	1,400	.....	.....
Quincy	M	213	9,322	3,327	.....
Springfield	M	1,406	15,737	2,257	.....
Whitehall	M	11,000	.....	.....	All Universal
Indiana:					Reports from 31 cities
Alexandria	M	.....	.....	.....	1,000′ of 2″ & 3″ w. i.
Columbia	M	1,900	400	.....	.....
Decatur	M	463	1,218	.....	.....
Elkhart	P	2,436	1,512	.....	.....
Evansville	M	.....	20,880	.....	.....
Huntington	M	1,795	3,598	.....	.....
Jasper	M	6,360	.....	.....	.....
Lafayette	M	2,666	1,433	.....	.....
La Porte	M	.....	447	13,876	.....
Lebanon	M	1,800	600	.....	.....
Nappanee	P	336	.....	.....	Universal
Newcastle	—	800	250	.....	.....
No. Manchester	M	4,000	.....	.....	All Universal
Rensselaer	M	2,800	.....	.....	.....
Richmond	P	540	4,828	.....	.....
Shelbyville	P	.....	1,500	.....	All Universal. 1,500′ of steel main smaller than 12″
South Bend	M	.....	17,000	.....	.....
Valparaiso	P	.....	.....	.....	Wood pipe used exclusively
Vincennes	—	.....	360	.....	.....
Washington	P	.....	.....	.....	2,436′ steel mains 12″ or smaller
Iowa:					Reports from 29 cities
Burlington	P	1,170	4,098	.....	.....
Cedar Rapids	M	.....	26,905	13,867	.....
Charles City	M	2,600	2,600	.....	.....
Cherokee	M	2,300	320	.....	.....
Davenport	P	.....	18,500	.....	.....
Des Moines	M	.....	27,563	.....	375′ of 6″ hydrant connections
Duhuque	M	718	24,405	.....	.....
Ft. Dodge	M	.....	11,000	.....	.....
Port Madison	P	.....	1,500	.....	.....
Hampton	M	6,000	.....	.....	.....
Knoxville	M	.....	350	.....	.....
Maquoketa	M	.....	600	.....	.....
Mason City	M	700	5,800	.....	.....
Muscatine	M	.....	2,640	7,920	.....
Nevada	M	600	.....	.....	.....
Newton	M	3,550	.....	.....	.....
Ottumwa	M	.....	18,000	.....	.....
Sioux City	M	48,366	13,956	110	.....
Washington	M	700	300	.....	.....
Winterset	—	650	.....	.....	All Universal
Kansas:					Reports from 16 cities
Atchison	P	.....	1,790	.....	2,500′ of w. i. mains ¾″ to 2″
Council Grove	M	2,600	.....	.....	.....
Dodge City	—	22,400	4,700	.....	.....
Fredonia	M	750	.....	.....	.....
Hays	M	5,000	2,000	.....	3,000′ steel mains 12″ or smaller
Hutchinson	P	.....	20,000	.....	.....

STREET MAINS LAID IN 1922—(Continued)

City	Plant municipal (M) or private (P)	Cast Iron Mains: Under 6″	6″, 8″, 10″ & 12″	Over 12″	Other kinds, and remarks
Kansas (Continued)					
Independence	M	2,600	.....	.....	.....
Junction City	M	54	500	.....	.....
Lawrence	M	27,785	43,484	2,300	All Universal
Manhattan	M	1,000	.....	.....	.....
Marysville	P	16,000	.....	.....	.....
Osawatomie	M	5,280	.....	.....	.....
Pittsburg	—	1,500	3,700	.....	.....
Kentucky:					Reports from 14 cities
Ashland	M	4,782	15,433	.....	5,427′ of w. i. main smaller than 12″
Bowling Green	M	.....	.....	.....	5,190′ steel main smaller than 12″
Covington	M	.....	14,000	.....	All Universal
Glasgow	P	.....	.....	.....	2 miles of steel main
Hopkinsville	P	268	887	.....	587′ with pre-made joints
Louisville	M	2,730	90,232	9,768	All Universal
Madisonville	—	1,000	.....	.....	.....
Paris	P	.....	500	.....	.....
Providence	M	1,200	.....	.....	All with pre-made joints
Louisiana:					Reports from 8 cities
Alexandria	M	.....	24,000	.....	.....
Baton Rouge	P	.....	7,100	.....	2,100′ was Universal. 20,000′ steel main 12″ or smaller
Minden	—	5,280	.....	.....	All Universal
New Orleans	M	16,072	90,131	14,500	.....
Rayne	M	.....	.....	.....	5,000′ steel main 12″ or smaller
Maine:					Reports from 6 cities
Calais	P	.....	200	.....	All Universal
Gardiner	M	400	700	.....	700′ with pre-made joints
Houlton	—	.....	568	.....	.....
Kittery	MP	.....	48	.....	Universal
Rockland and three other cities	P	.....	1,174	.....	4,277′ of 2″ w. i. pipe
Maryland:					Reports from 2 cities
Frostburg	M	400	.....	.....	.....
Massachusetts:					Reports from 44 cities
Adams	M	200	2,396	7,800	.....
Amesbury	M	3,710	320	.....	.....
Andover	—	.....	7,300	.....	.....
Athol	M	.....	4,964	.....	1,290′ was Universal
Attleboro	M	.....	2,196	.....	.....
Barnstable	P	2,616	.....	.....	2,616′ of steel mains 12″ or smaller
Belmont	M	.....	9,191	.....	.....
Brockton	M	.....	4,800	5,692	.....
Cambridge	M	359	4,631	.....	.....
Danvers	M	.....	11,033	77	.....
Falmouth	M	285	14,505	.....	2,500′ steel main 12″ or smaller
Fitchburg	M	.....	1,644	3,335	.....
Foxborough	M	100	2,200	.....	.....
Framingham	M	.....	24,772	.....	.....
Franklin	M	.....	2,500	.....	.....
Haverhill	M	964	10,580	.....	.....
Lexington	M	430	3,051	.....	.....
Malden	M	24	5,081	.....	.....
Mansfield	M	.....	10,300	.....	All Universal
Maynard	M	1,000	300	.....	.....
Milton	M	.....	6,069	.....	.....
New Bedford	M	98	25,765	12,071	.....
Newburyport	M	495	875	.....	.....
North Adams	M	400	4,480	.....	.....
Pittsfield	—	310	7,360	970	.....
Revere	M	.....	8,883	.....	300′ of 2″ galv.
Spencer	M	.....	970	.....	.....
Stoughton	M	.....	2,424	.....	.....
Swampscott	M	132	4,704	.....	.....
Taunton	M	.....	942	....	.....
New Jersey (Continued)					
Newark	M	948	19,681	3,030	.....
Nutley	M	.....	2,745	.....	.....
Perth Amboy	M	.....	2,795	.....	.....
Phillipsburg	—	.....	200	.....	.....
Ridgewood	M	.....	9,700	.....	1,200′ with pre-made joints
Rockaway	M	1,400	.....	.....	.....
Somerville	P	140	2,876	.....	.....
South Amboy	M	450	.....	.....	All Universal
South River	M	500	1,000	.....	.....
Westfield	P	.....	6,000	.....	.....
Woodbury	M	.....	4,950	.....	All Universal
New York:					Reports from 30 cities
Baldwinsville	M	.....	400	.....	.....
Dansville	—	1,500	2,180	.....	480′ Universal
East Syracuse	M	1,100	.....	.....	.....
Elmira	M	713	7,302	.....	2,400′ Universal
Frankfort	M	.....	1,050	.....	950′ Universal, 100′ with pre-made joints
Geneva	M	.....	2,400	.....	.....
Jamestown	M	1,011	18,054	5,443	1,924′ w. i. pipe, smaller than 12″
Kingston	M	150	500	2,000	.....
Little Falls	M	.....	2,400	.....	.....
Lowville	M	.....	68	.....	.....
Malone	M	2,709	.....	.....	All Universal
Middletown	M	510	.....	.....	.....
Mohawk	M	33	.....	.....	.....
Mount Vernon	M	5	2,134	.....	.....
Norwich	P	.....	696	.....	.....
Nyack	M	350	640	.....	.....
Olean	M	5,000	800	.....	.....
Oswego	M	.....	4,896	.....	.....
Peekskill	M	.....	1,660	.....	.....
Perry	M	600	1,800	.....	.....
Sidney	M	408	216	.....	72′ Universal
Southampton	P	4,011	1,096	.....	3,500′ Universal
Syracuse	M	.....	26,734	31,000	26,734′ Universal
Waterford	M	.....	1,450	.....	.....
North Carolina:					Reports from 12 cities
Canton	M	400	7,000	.....	.....
Charlotte	M	3,000	75,350	.....	400′ with pre-made joints
Greensboro	M	.....	30,300	4,000	.....
Greenville	M	2,600	.....	.....	.....
Kinston	M	.....	14,600	.....	.....
Monroe	M	.....	1,600	.....	.....
Morehead	M	.....	3,000	.....	All Universal
Rocky Mount	M	.....	8,700	.....	3,000′ of 2″ galv.
Salisbury	M	.....	1,000	.....	10,000′ steel mains, 12″ or smaller
Statesville	—	.....	7,000	.....	.....
Washington	M	.....	.....	.....	500′ steel mains, 2″ and smaller
Wilmington	—	.....	9,400	.....	.....
North Dakota:					Report from 1 city
Fargo	M	.....	7,700	.....	.....
Ohio:					Reports from 28 cities
Barnesville	M	500	.....	.....	.....
Bellefontaine	M	1,500	.....	.....	All Universal
Bellevue	M	1,600	.....	.....	.....
Cambridge	—	500	.....	.....	.....
Cincinnati	M	5,453	27,213	.....	.....
Circleville	P	.....	1,100	.....	500′ of 2″ galv.
Conneaut	M	.....	1,200	.....	.....
Fremont	M	1,421	2,490	.....	.....
Kenmore	M	20,000	600	.....	4,000′ Universal
Lakewood	M	100	5,966	.....	.....
Lancaster	M	6,240	.....	.....	400′ of 2″ steel main
Lima	M	6,901	88,297	2,486	.....
Marinette	M	500	11,000	.....	.....
Medina	M	.....	1,110	.....	All Universal

Waltham	M	336	3,545	.....	.....
Westfield	M	.....	3,025	.....	.....
Weymouth	M	.....	2,572	.....	.....
Winchendon	M	.....	1,000	.....	1,000′ of steel main 12″ or smaller
Michigan:					Reports from 26 cities
Alma	—	.....	.....	.....	5,000′ of 4″ and 6″ c. i.
Battle Creek	M	.....	9,330	.....	.....
Bay City	M	1,700	21,000	.....	12,000 steel mains 38″ diameter
Benton Harbor	M	.....	7,920	.....	.....
Big Rapids	M	1,000	.....	.....	.....
Coldwater	M	2,304	3,108	.....	.....
Detroit	M	660	17,180	.....	.....
Highland Park	M	1,356	4,170	.....	.....
Holland	M	108	2,943	.....	.....
Iron Mountain	—	.....	1,500	.....	.....
Ironwood	M	2,548	22,228	.....	.....
Jackson	M	.....	5,280	.....	.....
Ludington	M	.....	3,500	.....	.....
Mt. Clemens	M	19,000	.....	.....	.....
Mt. Pleasant	M	2,640	.....	.....	.....
St. Louis	—	6,300	1,275	.....	All Universal
South Haven	M	1,299	1,531	.....	.....
Traverse City	M	.....	1,800	.....	.....
Minnesota:					Reports from 16 cities
Alexandria	M	1,545	3,000	.....	All Universal
Bemidji	M	178	220	.....	All Universal
Duluth	—	.....	28,751	.....	.....
Hutchinson	M	4,000	2,000	.....	.....
Minneapolis	M	.....	76,564	2,722	.....
Moorhead	M	.....	2,000	.....	.....
Northfield	M	1,200	.....	.....	.....
Owatonna	M	200	3,500	.....	.....
Rochester	M	4,160	7,024	.....	.....
Two Harbors	M	750	.....	.....	.....
Waseca	M	8,686	.....	.....	.....
W. Minneapolis	M	4,968	.....	.....	All Universal
Mississippi:					Reports from 8 cities
Charleston	M	1,000	.....	.....	All Universal
Greenville	M	5,000	600	.....	2,000′ steel mains, 1½″ and 2″
Jackson	M	60	13,500	.....	.....
Missouri:					Reports from 9 cities
Kirksville	M	6,000	.....	.....	2,000′ steel mains, 12″ or smaller
Moberly	M	1,800	1,200	.....	.....
St. Louis	M	752	16,509	511	.....
Trenton	M	2,500	.....	.....	.....
Montana:					Reports from 3 cities
Bozeman	M	106	1,340	.....	600′ with pre-made joints
Kallispell	M	.....	760	.....	.....
Missoula	P	.....	.....	.....	300′ steel mains, 12″ or smaller
Nebraska:					Reports from 8 cities
Blair	—	1,000	.....	.....	All Universal
Chadron	M	4,700	510	.....	All Universal
Fairbury	—	28	12	.....	.....
Fremont	M	.....	6,247	.....	.....
Hastings	M	4,700	.....	.....	.....
Holdrege	M	5,400	1,410	.....	All Universal
Nebraska City	P	7,900	.....	.....	All Universal
Plattsmouth	—	.....	4,000	.....	.....
New Hampshire:					Reports from 4 cities
Lebanon	M	750	970	.....	All Universal
Manchester	M	458	15,206	5,727	.....
Newport	M	.....	350	.....	.....
New Jersey:					Reports from 22 cities
Bordentown	M	400	.....	.....	.....
Bridgeton	M	.....	3,900	.....	.....
Freehold	M	600	400	.....	.....
Glen Ridge	M	.....	300	.....	.....
Hawthorne	M	.....	5,000	.....	1,000′ Universal
Irvington	P	.....	10,577	.....	.....
Milltown	M	.....	108	.....	All Universal
Middletown	—	16,000	4,500	.....	.....
Mingo Junction	P	.....	.....	.....	500′ steel main, smaller than 12″
Montpelier	M	3,600	.....	.....	600′ steel main, smaller than 12″
Niles	M	.....	2,000	5,900	.....
Portsmouth	M	.....	23,204	.....	.....
Urbana	M	276	.....	.....	240′ of 1″ steel main
Willoughby	M	.....	6,000	.....	.....
Youngstown	P	.....	4,109	.....	.....
Oklahoma:					Reports from 7 cities
Ada	M	800	7,000	.....	.....
Perry	M	4,722	2,000	.....	10,000′ steel main, 12″ or smaller
Stillwater	M	2,150	3,250	.....	.....
Oregon:					Reports from 3 cities
Portland	M	97,648	49,452	216	.....
Pennsylvania:					Reports from 45 cities
Allentown	M	.....	7,475	.....	.....
Ambler	P	2,700	1,788	.....	.....
Blairsville	M	600	650	.....	.....
Bradford	M	100	950	.....	.....
Brookville	M	800	400	.....	.....
Catasauqua	—	300	.....	.....	200′ steel main less than 12″
Chambersburg	M	600	2,300	.....	.....
Connellsville	P	.....	2,000	.....	3,000′ steel main smaller than 12″
Danville	M	350	.....	.....	.....
Grove City	M	1,100	5	.....	Use leadite for joints
Hamburg	P	750	700	.....	.....
Hellertown	M	200	.....	.....	.....
Huntingdon	M	1,000	.....	.....	.....
Indiana	—	2,113	57	.....	.....
Kane	P	475	.....	.....	.....
Kittanning	P	.....	810	200	.....
Lancaster	M	1,280	10,059	804	550′ Universal, 6,000 with pre-made joints
Lebanon	—	1,200	7,800	.....	.....
Lehighton	P	3,300	.....	.....	.....
McDonald	P	400	300	.....	.....
Mechanicsburg	P	10,000	.....	.....	10,000′ steel main smaller than 12″
Media	M	1,200	.....	.....	All pre-made joints (McWayne)
Meyersdale	P	1,200	350	.....	525′ of 2″ steel main
Minersville	P	.....	1,909	.....	.....
Nazareth	P	800	1,500	.....	1,100′ Universal, 1,100′ with pre-made joints
North East	M	500	.....	.....	.....
Punxsutawney	—	1,200	900	.....	.....
Reynoldsville	M	1,740	.....	.....	90′ Universal
Ridgway	M	200	.....	.....	.....
Sayre	P	600	400	.....	.....
Somerset	M	.....	400	.....	.....
Stroudsburg	P	.....	3,000	.....	.....
Titusville	M	1,000	.....	.....	.....
Tyrone	P	1,215	.....	.....	.....
Rhode Island:					Reports from 3 cities
East Providence	P	1,544	720	.....	1,142′ of 2″ steel mains
Pawtucket	M	232	21,129	745	.....
Woonsocket	M	.....	7,959	.....	.....
South Carolina:					Reports from 10 cities
Charleston	M	.....	35,860	13,960	All cast iron cement lined
Cheraw	M	.....	.....	.....	1 mile galv. main
Chester	M	1,240	.....	.....	.....
Florence	M	3,000	22,000	.....	.....
Spartanburg	M	16,000	34,200	.....	.....
Sumter	M	3,000	1,400	.....	.....
South Dakota:					Reports from 2 cities
Rapid City	M	.....	2,935	.....	.....
Tennessee:					Reports from 12 cities
Covington	—	1,000	.....	.....	.....
Dyersburg	M	.....	2,250	.....	2,500′ of steel main smaller than 12″
Humboldt	M	3,000	.....	.....	All Universal

STREET MAINS LAID IN 1922—(Continued)

City	Plant municipal (M) or private (P)	Cast Iron Mains: Under 6″	6″, 8″, 10″ & 12″	Over 12″	Other kinds, and remarks
Tennessee (Continued)					
Jackson	M	.....	3,000	.....	.....
Maryville	M	1,200	200	.....	.....
Murfreesboro	M	400	6,500	.....	.....
Shelbyville	P	.....	.....	.....	3 miles steel mains smaller than 12″
Texas:					Reports from 16 cities
Childress	M	.....	57,000	354,000	.....
Cleburne	M	.....	.....	.....	2 miles steel main smaller than 12″
Del Rio	M	500	9,000	.....	.....
Greenville	M	.....	15,800	.....	.....
Longview	M	.....	4,000	.....	.....
Mart	—	3,000	.....	.....	.....
San Benito	P	7,750	9,951	.....	1,200′ steel mains 12″ or smaller
Stamford	M	.....	1,600	.....	.....
Weatherford	P	1,100	.....	.....	2,100′ steel main smaller than 12″
Utah:					Reports from 2 cities
Tooele	M	.....	.....	.....	790′ of 4″ wood pipe
Vermont:					Reports from 3 cities
Barre	M	253	185	117	117′ Universal
Newport	M	500	.....	.....	.....
Virginia:					
Richmond	M	1,418	48,863	12,826	.....
Washington:					Reports from 6 cities
Aberdeen	M	300	800	.....	4,000′ of 2″ steel mains. 150′ river crossing 6″ Universal. 650′ with pre-made joints
Auburn	M	5,000	2,200	.....	All Universal
Pullman	—	.....	5,000	.....	4,000′ Universal
Spokane	M	.....	4,648	.....	2,649′ of 12″ Kalameln; 11,233′ of 18″ to 30″ steel
West Virginia:					Reports from 4 cities
Elkins	M	2,500	3,450	.....	.....
Mannington	M	.....	.....	.....	1,000′ of 2″ and 250′ of 4″ steel mains
Wisconsin:					Reports from 32 cities
Ashland	P	12	804	.....	.....
Baraboo	M	.....	800	.....	.....
Beaver Dam	M	.....	350	.....	1,000′ galv. w. i.
Clintonville	M	475	1,300	.....	.....
Hartford	M	500	.....	.....	.....
Janesville	M	560	5,257	.....	.....
Jeffers	—	3,204	1,942	.....	All Universal
Kaukauna	M	364	850	.....	.....
Kenosha	M	260	19,194	1,910	.....
Ladysmith	M	3,214	5,424	.....	.....
Lake Geneva	—	8,000	.....	.....	.....
Lancaster	M	3,000	.....	.....	.....
Madison	M	414	8,838	.....	.....
Marinette	—	1,116	.....	.....	.....
Menasha	M	640	1,758	.....	.....
Milwaukee	M	.....	52,177	26,745	.....
Monroe	M	800	1,000	.....	.....
Neenah	—	2,000	600	.....	.....
Plymouth	M	800	.....	.....	.....
Racine	M	.....	2,608	72	.....
Reedsburg	—	200	1,402	.....	All Universal. 180′ of 10″ galv. w. i.
Shawano	M	1,050	.....	.....	.....
So. Milwaukee	M	.....	4,860	.....	.....
Stevens Point	—	.....	26,000	.....	8,000′ steel main smaller than 12″
Tomah	M	.....	.....	.....	1,000′ galv. w. i. 2″
Tomahawk	M	750	.....	.....	.....
Two Rivers	M	180	200	.....	.....
Washburn	P	486	.....	.....	.....
Watertown	M	1,486	7,047	.....	.....
Wyoming:					Reports from 2 cities
Evanston	M	500	.....	.....	800′ steel mains 12″ or smaller
Rock Springs	P	1,572	2,295	.....	.....

WATER PURIFICATION

City	Waterworks Municipal (M) or Private (P)	Is Sedimentation Basin Used?	What Kind of Filters?	Is Water Chlorinated?	Is Water Softened?	Is It Treated in Any Other Way?	Cost of Purification Plant	Millions of Gallons Treated Last Year.	Cost of Labor at Plant.	Cost of Chemicals.	Cost of Repairs.	Cost of Power.	Other Cost of Purification.
Alabama:													
Athens	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Jasper	P	Yes	Pressure	.....	.....	.....	$35,000.00	Installed Feb 1923	.....	.....	.....	.....	.....
Opelika	M	Yes	Gravity sand	Yes	Yes	No	12,000.00	10	$1,500.00	$1,280.00	$80.00	$10,800.00	None
Talladega	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Arizona:													
Phoenix	M	No	Infiltration gallery	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Prescott	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Arkansas:													
Benton	M	Yes	Slow sand	Yes	No	No	.....	46	.....	75.00	None	.....	.....
Blytheville	P	No	None	Yes	No	No	600.00	Just installed	.....	.....	.....	.....	.....
Hot Springs Nat'l Park	P	No	Gravity sand	Yes	No	Cop. sulph. in lakes	.....	512.00	960.00	727.00	1,869.00	.....	$242.00
Pine Bluff	P	Yes	None	No	No	Hydrated lime to reduce CO_2 and iron	1,000.00	720	.....	10,000.00	None	None	None
Russellville	P	Yes	Rapid sand	No	No	.....	.....	.....	.....	.....	.....	.....	.....

California:													
Glendale	..	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Red Bluff	M	No	None	Part	No	No	600.00	250	.....	80.00	.....	.....	.....
So. Pasadena	M	Yes	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Watsonville	M	Yes	Jewell	Yes	No	No	400.00	30	250.00	200.00	100.00	.....	.....
Colorado:													
Longmont	M	No	None	Yes	No	No	800.00	747	31.50	160.00	6.97	None	88.79
Montrose	M	Yes	None	Yes	No	No	2,000.00	180	50.00	181.43	.....	.....	.....
Connecticut													
Ansonia	P	No	None	Yes	No	Cop. sulph.	9,250.00	729	906.00	425.00	356.00	50.00	.....
Bridgeport	P	No	None	Yes	No	Cop. sulph.	.....	20	.....	.....	.....	.....	.....
Bristol	M	No	None	Being installed	No	No	6,500.00	.....	.....	.....	.....	.....	.....
Putnam	M	Yes	Rapid sand	Yes	No	No	75,000.00	.....	959.00	.....	94.40	2,374.00	.....
Southington	M	No	None	Yes	No	No	4,700.00b	225	96.67	60.00	270.30	None	.....
Torrington	P	No	None	Yes	No	No	.....	.....	.....	.....	266.42	.....	.....
Willimantic	..	No	None	Yes	No	No	$1,000.00	547.5	None	84.00	None	.....	None
Florida													
Orlando	M	...	National	Yes	No	Lime	102,500.00	Being installed	.....	.....	.....	.....	.....
Georgia													
Carrollton	M	Yes	Greer and New York Jewell	Chloride of lime	No	...	20,000.00	6	1,400.00	750.00	None	$2,400.00	.....
La Grange	M	Yes	Am. Water Softener Company	Yes	No	...	35,000.00	360	.....	1,442.00	$571.00	2,584.00	.....
Idaho													
Kellogg	P	No	None	Yes	No	No	1,500.00c	.....	.....	96.00	75.00	20.00	.....
Lewiston	M	Yes	To be voted on May 22	Yes	No	No	.....	594.6	.....	308.00	170.00	.....	.....
Montpelier	M	Yes	None	Yes	No	No	2,000.00	220	420.00	72.00	75.00	300.00	None
Twin Falls	M	Yes	Pittsburgh Filter Co.	Yes	Yes	No	250,000.00	1,500	19,000.00	7,000.00	185.60	1,500.00	None
Illinois													
Centralia	M	No	None	Yes	No	No	.....	730	.....	Chlorine	.....	.....	.....
Decatur	M	Yes	Continental-Jewell	Yes	No	...	135,000.00	1,805.7	4,860.00	6,807.00	288.26	1,709.00	.....
Evanston	M	Yes	Rapid sand	Yes	No	...	250,000.00	2,509.2	10,000.00	4,500.00	175.00	150.00	.....
Johnston City	M	Yes	Rapid sand	Yes	No	Lime	325,000.00a	4.5	New plant	.....	.....	.....	.....
Lake Forest	M	Yes	Jewell and American	Yes	No	...	.....	300	.....	500.00	100.00	None	.....
Moline	M	Yes	Jewell	Yes	No	...	40,000.00	968	7,280.00	6,695.00	4,446.00	.....	.....
Mt. Carmel	M	Yes	Sand	Yes	No	...	25,000.00	365	3,500.00	2,000.00	1,600.00	14,000.00	1,800.00
Paris	M	Yes	Rapid sand	Yes	No	No	New plant	.....	.....	.....	.....	.....	.....
Quincy	M	Yes	Rapid sand	Yes	No	No	100,000.00	615	2,570.00	5,761.00	833.80	1,301.00	None
Springfield	M	No	None	Part	...	...	.....	.....	.....	.....	.....	.....	.....
Streator	P	Yes	Rapid sand	Yes	No	...	.....	700	1,156.03	.....	76.73	.....	.....
Indiana:													
Evansville	M	Yes	Norwood, rapid sand	Yes	No	...	269,601.00	3,183	11,367.00	14,194.00	1,769.00	.....	.....
Jasper	M	No	International, sand	Yes	No	No	10,000.00	61.2	450.00	280.00	10.00	2,260.00	None
Lebanon	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Richmond	P	No	None	Emergency	No	...	.....	.....	.....	.....	.....	.....	.....
Seymour	P	Yes	Mechanical	Yes	No	No	.....	300	.....	.....	.....	.....	.....
Shelbyville	P	No	None	Yes	No	No	.....	310	.....	59.53	.....	.....	.....
Valparaiso	P	Yes	Gravity, rapid sand	Yes	No	No	18,000.00	334	2,000.00d	1,160.00	150.00	3,700.00d	None
Vincennes	..	Yes	N.Y. Cont- Jewell Co.	Yes	No	...	.....	700	1,500.00	1,800.00	.....	.....	.....
Washington	P	Yes	Norwood, rapid sand	Yes	No	...	35,000.00	426.8	.....	3,000.00	250.00	.....	.....
Iowa:													
Atlantic	M	Yes	.....	Very limited	...	Aerate	.....	1.5	50.00	15.00	.....	.....	.....
Burlington	P	Yes	Norwood, grav. sand	Yes	No	No	88,411.00	1,018.3	4,818.00	9,955.00	.....	18,476.00	.....
Cedar Rapids	M	Yes	Gravity, rapid sand	Yes	No	No	50,000.00	1,399	5,407.00	5,242.00	1,060.00	60.00	.....
Cherokee	M	No	.....	Yes	No	No	800.00	6.8	None	56.00	25.00	None	None
Clarinda	M	Yes	Rapid sand	Yes	No	No	75,000.00	100	1,200.00	867.00	80.00	2,053.00	300.00
Davenport	P	Yes	Pressure	Yes	No	No	.....	1,500	.....	.....	.....	.....	.....
Des Moines	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Dubuque	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Fort Madison	P	Yes	Rapid sand	Yes	No	No	60,000.00	225	.....	2,000.00	.....	.....	.....
Keokuk	P	Yes	Pressure	Yes	No	...	.....	600	.....	.....	.....	.....	.....
Knoxville	M	No	Infiltration	...	...	...	.....	.....	.....	.....	.....	.....	.....
Muscatine	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Nevada	..	Yes	None	No	No	Aerate	.....	.....	.....	.....	.....	.....	.....
Newton	M	No	None	Yes	No	No	.....	90.3	.....	12.00	.....	.....	.....
Ottumwa	M	Yes	Rapid sand	Yes	No	No	38,420.00	825	2,400.00	15,000.00	.....	.....	.....
Sac City	M	...	.....	Yes	...	...	600.00	48	Very small	7.00	2.00	None	None
Kansas:													
Atchison	P	Yes	None	Yes	No	...	.....	500	448.00	2,896.00	.....	.....	.....
Council Grove	M	Yes	Open gravity	Yes	No	No	20,000.00	96.9	.....	492.00	192.00	581.00	25.00
Fredonia	M	Yes	Gravity rapid	Yes	No	...	40,000.00	100	1,200.00	900.00	New	725.00	None
Independence	M	Yes	Yes	Yes	No	...	.....	.....	.....	2,662.00	443.65	.....	150.00e

WATER PURIFICATION

City	Waterworks, Municipal (M) Or Private (P)	Is Sedimentation Basin Used?	What Kind of Filters?	Is Water Chlorinated?	Is Water Softened?	Is It Treated In Any Other Way?	Cost of Purification Plant	Millions of Gallons Treated Last Year.	Cost of Labor at Plant.	Cost of Chemicals.	Cost of Repairs.	Cost of Power.	Other Cost of Purification.
Kansas (Continued)													
Junction City....	M	No	None	Yes	No	No	.....	.....	.....	10.00	.....	.....	.....
Lawrence	M	Yes	Sand	Yes	Yes	No	.....	15	.....	.....	.....	.....	.....
Manhattan	M	Yes	Rapid sand	Emergency	Yes	Remove iron	66,000.00	Just completed	.....	.....	.....	.....	.....
Marysville	P	Yes	Pittsburg slow gravity feed	Yes	No	...	30,000.00	100	3,000.00	1,652.00f	.....	.....	.....
Osawatomie	M	Yes	N. Y. Cont. Jewell	Yes	No	Yes	.....	292	800.00	150.00	.....	.....	.....
Pittsburg	..	No	None	No	No	Aerate	.....	.....	.....	.....	.....	.....	.....
Topeka	..	Yes	Rapid sand	Yes	Yes	Yes	535,000.00	140	4,368.00	6,874.00	None	2,864.00	.....
Kentucky:													
Ashland	M	Yes	Rapid sand	Yes	No	No	24,207.00	487	184.74	3,596.00	297.53	None	121.19
Bowling Green... ..		Yes	Roberts	Yes	Yes	...	.....	372.3	1,548.00	900.00	22.00	1,820.00	.....
Catlettsburg	P	Yes	None	Yes	No	...	.....	435	.....	2,500	.....	.....	1,874.00g
Covington	M	Yes	.....	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Frankfort	M	Yes	Slow sand	Yes	No	No	.....	2	.....	.....	.....	.....	.....
Glasgow	P	Yes	None	Yes	No	No	.....	.....	.....	315.00	35.00	.....	.....
Hopkinsville	P	Yes	None	Yes	No	...	11,500.00	190	500.00	1,800.00	150.00	1,500.00	None
Louisville	M	Yes	Rapid sand	Yes	...	...	1,394,883.00	13,122	15,615.00	.....	2,974.00	34,903.00	.....
Middlesborough..	P	No	None	Yes	No	No	800.00	255.5	150.00	60.00	75.00	None	None
Morganfield	M	Yes	None	No	...	...	.....	.....	.....	.....	.....	.....	.....
Paris	P	Yes	Rapid sand	Yes	...	...	12,000.00	292	.....	1,000.00	1,000.00	50.00	.....
Louisiana:													
Lake Charles.....	P	No	None	Emergency	No	No	.....	.....	.....	.....	.....	.....	.....
New Orleans.....	M	Yes	Rapid gravity sand	Yes	Yes	...	000,000.00h	15,284	.....	65,000.00	.....	.....	1
Maine													
Gardiner	M	No	Slow sand	No	No	N	69,000.00	.....	1,496.00	.....	155.64	.....	.....
Houltan	..	No	.....	Yes	No	No	416.98	292.5	.....	241.40	7.50	.....	.....
Maryland													
Frostburg	M	No	None	Chlorinated lime, emergency	...	...	.....	10	200.00	60.40	None	.....	.....
Massachusetts													
Adams	M	Yes	None	No	No	No	.....	.....	.....	.....	.....	.....	.....
Athol	M	No	Rapid sand and slow sand	No	No	...	.....	300	.....	.....	.....	.....	.....
Attleboro	M	...	Natural gravel	No	No	No	.....	.....	.....	.....	.....	.....	.....
Cambridge	M	Yes	Yes	...	...	...	700,000.00+	Just completing	.....	.....	.....	.....	.....
Dalton	M	Yes	None	No	No	No	.....	.....	.....	.....	.....	.....	.....
Framingham	M	No	Filter galleries	Yes	No	No	500.00	413.8	.....	.....	125.00	.....	.....
Newburyport	M	...	Sand	No	No	No	.....	.....	.....	.....	.....	.....	.....
Westboro	M	Yes	Natural	No	No	No	Nothing	.....	.....	.....	.....	.....	.....
Michigan													
Battle Creek.....	M	...	.....	Yes	No	No	.....	1,329	.....	1,450.00	6,150.00	16,656.00	.....
Bay City.....	M	No	None	Yes	No	No	Under construction						
Benton Harbor...	M	Yes	Sand	Yes	Yes	No	200,000.00	Just started		.....	.....	.....	.....
Big Rapids.....	M	...		Yes	No	No	.....	90	.....	.....	.....	.....	.....
Highland Park...	M	Yes	Gravity rapid sand	Yes	No	No	760,000.00	2,143.9	10,950.00	2,898.00	500.00	.....	None
Iron Mountain...	..	No	None	Yes	No	No	1,000.00	286	.....	120.00	75.00	.....	None
Ironwood	M	No	None	Yes	No	No	.....	676	1,000.00	255.00	13.00	.....	.....
Jackson	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Ludington	M	No	None	Yes	No	No	350.00	450	Nothing	100.00	Nothing	25.00	None
Marine City.....	M	No	Nothing	Yes	No	No	.....	547	3,600.00	125.00	2,500.00	.....	.....
Mt. Pleasant.....	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Niles	M	No	None	Yes	...	...	800.00	240	None	84.00	100.00	.....	.....
Otsego	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
South Haven.....	M	No	None	Yes	No	No	.....	229.8	600.00	.....	.....	.....	.....
Traverse City....	M	No	None	Yes	No	No	550.00	.....	.....	.....	.....	.....	.....
Wyandotte	M	Yes	Rapid sand	Both before and after filtration	No	...	300,000.00	900	9,000.00	3,125.00	300.00	7,517.00	.....

Minnesota													
Duluth	..	No	None	Yes	No	No	.....	3,248	None	833.45	None	None	None
Fairmont	M	..	.....	Yes	...	...	.....	.....	.....	.....	.....	.....	.....
Lake City	..	..	Sand	Lime hypo. in spring	...	...	.....	.....	.....	.....	.....	.....	.....
Minneapolis	M	Yes	Rapid sand	Yes	No	No	1,597,939.00	14,874	45,201.00	67,853.00	20,848.00k	3,819.00	1
Two Harbors	M	Yes	.....	Yes	No	...	.....	.....	114.72k	.....	.....	.....	.....
Mississippi:													
Jackson	M	Yes	N. Y. Cont.-Jewell	Yes	No	No	85,000.00	1,200	500.00	7,885.00	300.00	6,000.00	.....
Vicksburg	M	Yes	Rapid sand	Yes	No	No	.....	1,000	1,500.00	6,000.00	600.00	300.00	None
Yazoo City	..	No	None	Yes	No	No	.....	Just begun	.....	.....	.....	.....	.....
Missouri:													
Kirksville	M	Yes	Rapid sand	No	No	No	25,000.00	162	3,600.00	1,000.00	.....	4,500.00	.....
Macon	M	Yes	Pittsburgh	Yes	No	No	6,000.00	235.8	700.00	2,540.00	10.00	16,254.00	.....
Moberly	M	Yes	Rapid sand	Yes	No	No	57,869.00	208.1	.....	1,790.00m	.....	8,684.00	.....
St. Louis	M	Yes	Rapid sand	Yes	Yes	No	1,600,000.00	40,900	73,211.00	307,159.00	7,362.00	19,223.00	54,806.00
Trenton	M	Yes	Mechanical	No	No	...	.....	90	.....	800.00	1,500.00	25,000.00	.....
Montana:													
Bozeman	M	Yes	None	Part, summer only	No	No	500.00	195	.....	10.00	None	None	None
Missoula	P	No	None	Yes	No	No	550.00	36	50.00	150.00	25.00	.....	.....
Nebraska:													
Chadron	M	No	Infiltrat'n thro. grav.	...	...	No	.....	.....	.....	.....	.....	.....	.....
Nebraska City	P	Yes	None	Yes	No	...	.....	720	.....	3,000.00	2,100.00	26,000.00	.....
Plattsmouth	P	Yes	Rapid sand	No	No	No	.....	.....	.....	.....	.....	.....	.....
New Hampshire:													
Lebanon	M	No	N. Y. Cont.-Jewell	Yes	Yes	No	3,000.00	116.7	1,088.00	100.00	90.00	None	None
Walpole	P	No	Sand	No	No	No	.....	.....	.....	.....	.....	.....	.....
New Jersey:													
Bridgeton	M	..	Mechanical	Yes	No	...	75,000.00	700	2,500.00	3,800.00	None	None	None
Hightstown	M	No	Pressure	No	No	...	1,800.00	50	.....	600.00	None	.....	None
Newark	M	No	None	Yes	No	No	.....	16,008	.....	.....	.....	.....	.....
Nutley	M	Yes	Rapid sand	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Perth Amboy	M	No	Sand	...	...	...	.....	.....	.....	.....	.....	.....	.....
Phillipsburg	..	No	Sand	No	No	Cop. sulph.	.....	.....	.....	20.00	.....	.....	.....
Ridgewood	M	No	None	Yes	No	No	.....	294.5	.....	.....	.....	.....	.....
Rockaway	M	..	.....	Yes	No	No	1,000.00	15	200.00	80.00	72.00	.....	.....
Somerville	P	No	N. Y. Cont.-Jewell	Yes	No	...	.....	683	.....	1,844.00	822.13	.....	.....
South Amboy	M	No	None	Yes	No	No	12,500.00	302.2	.....	2,656.00	727.31	.....	None
New York:													
Canton	M	No	None	Yes	No	No	1,050.00	55	None	.....	.....	.....	.....
Dansville	..	..	.....	Yes	...	Cop. sulph.	2,100.00	450	250.00	27.00	25.00	.....	.....
East Syracuse	M	No	None	Yes	No	No	850.00	.....	240.00	36.00	50.00	None	None
Elmira	M	No	Slow sand	Yes	No	...	.....	1,638.5	10,026.00	4,656.00	3,139.00	.....	.....
Geneva	M	No	Slow sand	No	No	No	100,000.00	700	320.00	None	300.00	None	.....
Hudson	M	No	Slow sand	Yes	No	No	1,500.00n	912.5	1,536.00	175.00	250.00	None	None
Kingston	M	No	Rapid sand	Yes	No	...	.....	1,041.4	.....	.....	.....	.....	.....
Le Roy	M	Yes	Rapid sand	No	No	...	12,800.00	91	1,000.00	188.44	50.00	320.83	.....
Little Falls	M	No	Slow sand on part of supply	Yes	No	No	.....	1.117n	.....	.....	.....	.....	.....
Middletown	M	No	Grav., 5 mil. gal. cap., pressure, 3 mil. gal.	No	No	No	.....	1,231.5	5,000.00	1,012.00	284.09	528.46	.....
Mount Vernon	M	Yes	Rapid sand	Yes	No	No	.....	.....	p	.....	.....	.....	.....
Norwich	P	No	N. Y. Cont.-Jewell	Hypochlorite	No	No	33,000.00	650	1,500.00	3,300.00	500.00	None	.....
Nyack	M	No	Sand	Yes	No	No	.....	292	863.25	None	60.00	10,486.00	.....
Olean	M	Yes	Rapid sand	Yes	No	No	185,000.00	500	5,000.00	1,000.00	200.00	12,000.00	None
Oswego	M	No	None	Yes	No	No	2,000.00	1,744.6	.....	313.50	None	None	.....
Peekskill	M	Yes	Slow sand	Seldom	No	No	100,000.00	1,115.5	3,239.00	20.00	1,056.00	2,004.00	500.00
Perry	M	No	Slow sand	Yes	No	No	40,000.00	330	500.00	60.00	125.00	800.00	None
Sidney	M	Yes	Rapid sand	No	No	No	.....	.....	.....	.....	1,968.00	.....	500.00r
Syracuse	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Walton	P	No	N. Y. Cont.-Jewell	Yes	No	No	25,000.00	87	1,000.00	300.00	300.00	.....	.....
Waterford	M	Yes	N. Y. Cont.-Jewell	Yes	No	No	50,000.00	149	1,500.00	1,300.00	75.00	750.00	.....
Wellsville	M	Yes	Rapid sand	Slightly	No	Soda ash	42,000.00	190.9	2,661.00	829.73	17.65	6,849.00	.....
North Carolina:													
Canton	M	Yes	Pressure	Yes	No	No	600.00	109	.....	.....	.....	.....	.....
Charlotte	M	Yes	Rapid sand (Jackson)	Yes	No	No	.....	1,525.7	.....	.....	.....	.....	.....
Greensboro	M	Yes	Gravity rapid	Yes	No	No	.....	300	.....	.....	.....	.....	.....
Greenville	M	Yes	Gravity	Yes	No	No	100,000.00	.....	.....	.....	.....	.....	.....
Monroe	M	...	.....	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Rocky Mount	M	Yes	N. Y. Cont.-Jewell	Yes	No	No	.....	95	.....	1,600.00	.....	26,180.00	.....

WATER PURIFICATION

City	Waterworks Municipal (M) Or Private (P)	Is Sedimentation Basin Used?	What Kind of Filters?	Is Water Chlorinated?	Is Water Softened?	Is It Treated In Any Other Way?	Cost of Purification Plant	Millions of Gallons Treated Last Year.	Cost of Labor at Plant.	Cost of Chemicals.	Cost of Repairs.	Cost of Power.	Other Cost of Purification.
North Carolina (Continued)													
Salisbury	M	Yes	N. Y. Cont.-Jewell	Hypochlorite	No	No	216,850.00s	1,003.7	6,760.00s	2,929.00	502.00	.....	None
Statesville	..	Yes	Roberts	Yes	No	Cop. sulph.	38,000.00	24	240.00	.....	None	None	.....
Washington	M	Yes	Gravity	Yes	Yes	Yes	20,000.00	36.5	.....	800.00	100.00	.....	None
Wilmington	..	Yes	Gravity rapid sand	Yes	No	...	.....	1,095	5,460.00	14,000.00	1,100.00	.....	3,000.00t
North Dakota:													
Fargo	M	Yes	Rapid sand	Yes	Yes	...	250,000.00	800	.....	.....	.....	.....	.....
Ohio:													
Barnesville	M	Yes	Rapid sand	Yes	No	...	20,000.00	96	1,642.00	300.00	100.00	None	.....
Cambridge	..	Yes	Rapid sand	Yes	No	No	25,000.00	600	6,000.00	2,000.00	800.00	.....	800.00
Cincinnati	M	Yes	Rapid sand	Yes	No	No	.....	18,407.8	96,995.00	47,484.00	21,374.00	.....	.....
Circleville	P	...	Yes	No	No	Unknown	None	.....	.....	.....	.....	.....	.....
Conneaut	M	Yes	Rapid sand	Yes	No	...	.....	.....	.....	.....	.....	.....	.....
Delaware	P	...	Sand	Yes	Yes	No	100,000.00	Just Installed	.....	.....	.....	.....	.....
Kenmore	M	Yes	None	No	No	No	.....	.....	.....	.....	.....	.....	.....
Lima	M	Yes	Gravity rapid sand	Yes	No	No	125,000.00	1,682	7,956.00	8,500.00	1,260.00	4,364.00	None
Marietta	M	...	Rapid sand	Yes	No	No	57,000.00	800	.....	.....	.....	.....	.....
Medina	M	Yes	Rapid sand	Yes	Yes	Cop. sulph.	25,000.00	82.3	3,730.00	2,425.00	230.27	1,623.00	896.18u
Mingo Junction	P	No	None	Yes	No	No	350.00	98.4	.....	29.00	15.00	None	.....
Niles	M	Yes	Rapid sand	Yes	No	No	50,000.00	1,068.1	5,498.00	5,478.00	810.00	20,207.00	1,122.00t
Portsmouth	M	Yes	N. Y. Cont.-Jewell	Yes	...	...	140,000.00	1,500	4,200.00	7,250.00	1,350.00	200.00	5,700.00
Shelby	P	Yes	Rapid sand	No	No	No	50,000.00	300	2,000.00	.....	.....	3,000.00	.....
Willoughby	M	Yes	Sand	Yes	No	...	.....	.....	3,500.00	700.00	350.00	2,031.00	.....
Struthers	P	Yes	None	Yes	Yes	Excess lime	5,146.00	77.8	1,681.00	1,104.00	922.69	771.81	.....
Oklahoma:													
Collinsville	M	Yes	Pittsburgh Filter Co.	Yes	No	...	40,000.00	.....	None	150.00	10.00	None	None
Perry	M	Yes	Yes	Yes	No	...	100,000.00	.....	.....	.....	.....	.....	.....
Stillwater	M	Yes	Pittsburgh	Yes	...	...	.....	175	4,200.00	2,400.00	210.00	7,350.00	.....
Wagoner	M	No	Pittsburgh Filter Co.	Yes	No	...	.....	.....	.....	500.00	1,000.00	.....	25.00
Walters	M	...	.....	Yes	...	Cop. sulph.	.....	.....	.....	.....	.....	.....	.....
Oregon:													
The Dalles	M	No	None	Yes	No	No	1,000.00	1,460	1,080.00	193.42	None	None	None
Pennsylvania:													
Allentown	M	No	None	Yes	No	No	No plant	.....	.....	.....	.....	.....	.....
Ambler	P	Yes	None	Install'g plant	No	Cop. sulph.	.....	.....	.....	.....	.....	.....	.....
Braddock	M	Yes	None	Yes	No	Yes	.....	.....	.....	3,500.00	.....	.....	.....
Brookville	M	Yes	Rapid sand	Yes	No	...	.....	.....	.....	.....	.....	.....	.....
Chambersburg	M	No	None	Yes	...	...	200.00 -	950	875.00	30.00	5.00	.....	.....
Connellsville	P	Yes	Pressure	Yes	No	...	.....	807	.....	.....	.....	.....	.....
Danville	M	Yes	N. Y. Cont.-Jewell	Yes	...	...	.....	350	.....	1,060.00	.....	2,906.00	.....
Huntingdon	M	Yes	None	Yes	No	No	100.00	284.8	500.00	91.74	10.00	.....	50.00e
Indiana	..	Yes	Yes	Yes	No	...	.....	232.9	685.50	774.27	506.02	.....	.....
Jersey Shore	P	Yes	Rapid sand	Hypochlorite	No	...	32,000.00	540	2,500.00	250.00	1,800.00	.....	.....
Juniata	M	No	No	Warm weather	No	No	.....	.....	.....	50.00	.....	.....	.....
Kittanning	P	Yes	Gravity mechanical	Yes	No	No	125,000.00	500	875.00	1,500.00	.....	250.00	.....
Lancaster	M	Yes	Slow sand	Yes	No	No	225,000.00	2,870.9	.....	.....	.....	.....	.....
Lebanon	M	...	.....	Hypochlorite	No	Cop. sulph.	.....	700	.....	250.00	.....	.....	.....
McDonald	P	Yes	Scaife mechanical	Yes	No	...	15,443.00	131	500.00	356.72	None	None	None
Mechanicsburg	P	Yes	Pittsburgh	Yes	No	No	.....	.....	2,500.00	.....	.....	.....	.....
Media	M	Yes	Pressure	Yes	No	...	54,000.00	207.9	585.00	675.90	366.34	.....	.....
North East	M	No	Rapid sand	Yes	No	...	3,000.00	90	100.00	40.00	50.00	None	None
Parkersburg	P	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Punxsutawney	..	Yes	Pressure	Yes	No	...	.....	500	1,230.00	425.38	969.53	.....	.....
Reynoldsville	M	No	None	Yes	No	No	495.00	110	29.75	8.60	67.00	None	None
Ridgway	M	Yes	Rapid sand	Yes	No	No	100,000.00	460	4,500.00	300.00	1,000.00	6,500.00	.....
Sayre	P	No	Rapid sand	Yes	No	No	80,000.00	300	.....	.....	.....	.....	.....
Somerset	M	...	.....	When necess'ry	No	No	.....	.....	.....	.....	.....	.....	.....
Stroudsburg	P	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Tarentum	M	Yes	Pittsburgh Filter Co.	Yes	No	No	.....	250	5,000.00	1,200.00	1,892.00	4,200.00	None
Tyrone	P	No	None	Yes	No	No	2,648.00	1,000	561.85	856.00	None	None	None
West Newton	P	No	None	Hypochlorite	No	No	Home-made	54	.....	.....	.....	.....	.....

Rhode Island:													
East Providence..	P	Yes	N. Y. Cont.-Jewell	Yes	No	No	140,000.00	658.4	.....	5,140.00	160.00w	.....	.....
Pawtucket	M	No	None	Yes	No	No	.....	3,452	None	.....	.....	.....	.....
Woonsocket	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
South Carolina:													
Bennettsville	M	No	None	No	No	Soda ash	.....	75	300.00	300.00	.....	60.00	.....
Charleston	M	Yes	Gravity mechanical	Yes	Restore alkalinity with soda	Cop. sulph.	135,000.00x	2,313	.....	.....	.....	.....	.....
Cheraw	M	Yes	Am. W. Softener Co.	No	...	Soda ash	.....	50	3,000.00y	1,400.00	200.00	2,000.00	None
Chester	M	Yes	Roberts, wood tubs	Yes	When necessary	...	.....	.....	.....	.....	.....	.....	.....
Easley	M	Yes	Gravity sand	No	No	No	2,500.00	75	1,200.00	500.00	200.00	.....	.....
Spartanburg	M	Yes	Pittsburg slow sand	Yes	No	...	.....	600	.....	2,550.00	10,335.00k	8,350.00	None
Tennessee:													
Clarksville	M	Yes	Gravity	Yes	No	...	675.00	300	Nothing	900.00	Nothing	Very little	None
Dyersburg	M	Yes	Rapid sand	When river water used	No	Aeration	35,000.00	250	2,000.00	50.00	100.00	25.00	None
Fayetteville	M	...	.....	Yes	No	No	.....	137	150.00	.....	Nothing	.....	.....
Murfreesboro	M	No	Pressure	Yes	No	...	10,000.00	180	.....	.....	.....	.....	.....
Paris	M	Yes	.....	...	...	...	25,000.00	146	None	.....	.....	.....	300.00
Shelbyville	P	Yes	Slow sand	Yes	No	...	35,000.00	84	780.00	616.00	150.00	2,160.00	.....
Texas:													.....
Cameron	P	Yes	.....	Yes	No	No	17,500.00	15	500.00	600.00	.....	4,300.00	.....
Childress	M	Yes	Yes	Yes	No	No	30,000.00	None	.....	.....	.....	.....	None
Cleburne	M	No	None	Yes	No	No	.....	.....	.....	25.00	75.00	None	None
Eagle Pass.....	P	No	Infiltrat'n thro. grav.	Yes	No	No	Home-made	180	None	130.00	None	None	.....
Greenville	M	Yes	None	Yes	No	Cop. sulph.	None	.....	.....	.....	.....	.....	.....
Longview	M	Yes	Gravity	Yes	No	Yes	27,501.00	83	1,850.00	1,130.00	.....	.....	.....
Navasota	P	No	None	Yes	No	No	1,000.00	Just installed	.....	.....	.....	.....	.....
San Benito.....	P	Yes	None	Yes	No	No	.....	Just installed	.....	.....	.....	.....	.....
Stamford	M	No	None	Yes	...	...	.....	.....	.....	.....	.....	.....	.....
Weatherford	P	No	None	Yes	No	No	.....	55	None	25.00	45.00	None	None
Vermont:													
Barton	M	Yes	Brick	No	No	No	.....	.....	.....	.....	.....	.....	.....
Washington:													
Tacoma	M	No	None	Yes	No	No	7,000.00	15,330	500.00	4,971.00	931.00	.....	.....
West Virginia:													
Elkins	M	Yes	N. Y. Cont.-Jewell	Yes	No	...	85,000.00	8	200.00	300.00	.....	7,000.00	300.00
Martinsburg	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Sistersville	M	Yes	Rapid sand	Yes	No	No	40,000.00	250	2,725.00	640.00	600.00	1,900.00	None
Wisconsin:													
Ashland	P	No	Slow sand	Yes	No	No	80,000.00	512.7	420.00	75.00	85.17	None	959.23e
Kenosha	M	Yes	N. Y. Cont.-Jewell	Yes	No	Yes	88,398.00	1,760.3	6,489.00	6,101.00z	210.00	.....	340.00
Marinette	..	Yes	Jewell	Yes	No	...	.....	603.1	550.00	1,187.00	50.00	200.00	50.00e
Menasha	M	...	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Milwaukee	M	No	None	Yes	No	No	.....	23,646.9	66.56	2,788.00	.....	None	382.54
Racine	M	No	None	Yes	No	No	.....	2,156.4	174.71	373.32	None	None	None
Rhinelander	M	...	.....	Yes	...	...	.....	.....	.....	.....	.....	.....	.....
Shawano	M	...	Sand	Yes	...	...	.....	.....	.....	.....	.....	.....	.....
South Milwaukee.	M	Yes	Rapid sand	Yes	No	No	.....	300	.....	1,600.00	.....	.....	.....
Two Rivers.....	M	...	.....	Yes	No	No	.....	127.8	.....	58.41	.....	.....	.....
Washburn	P	...	.....	Yes	...	...	.....	.....	.....	.....	.....	.....	.....
Wyoming:													
Rock Springs....	P	Yes	Rapid sand	Yes	No	No	63,000.00	659.7	4,444.00	1,180.00	188.76	7,300.00	.....

a—Includes reservoir. b—Includes Venturi meter. c—Also $350 for building for chlorine plant. d—Estimated; records not separate from rest of water works. e—making analyses. f—Total cost of treating. g—Labor, maintenance, etc. h—Includes pumping plant and buildings. l—Exclusive of interest and depreciation, purification cost $9.12 per million gallons; including pumping and care of park and grounds, water cost $20.15 delivered into the distribution system. k—Include maintenance. l—Total cost $154.045. m—For 9 months, approximate. n—Chlorinating plant only. p—Water is purchased by city from New York Interurban Water Co., which purifies it. r—Patrolling streams. s—Including raw water station and pipe line. t—For chemist and bacteriologist. u—$290.52 for laboratory, $447.71 for filters, $157.95 for chemical apparatus. v—Labor $60.91, chemist $1,275, operator $345. w—Material only. x—Not including buildings and sedimentation basin. y—Including superintendent's salary. z—Includes repairs and supplies.

Refuse Utilization in England

Utilization of municipal refuse is making considerable headway in England, some of the more important cities which have recently undertaken it being Sheffield, Birmingham, Stoke-on-Trent, Westminster, Oldham and Newark. Some of the newer features are the automatic loading of the screenings into canal boats and the provision of a pneumatic dust suction plant to handle all dust from screens and flues, providing destructors for the destruction of the material which is not salable, and utilizing the steam for generation of electricity for charging electric vehicles, driving the machinery around the plant and lighting the plant.

One of the Birmingham plants is estimated to cost about $450,000 and will probably be the most modern of the kind in the country. At this plant the refuse will first be screened, the screenings being sold as a low-grade fertilizer and removed by canal after being automatically loaded into canal boats, or by rail, whichever offers the lower rates. Material removed by the screens will be deposited on sorting belts from which articles of commercial value will be removed and the combustible material will be delivered by the belts to the incinerators. The clinker from the latter will be crushed and screened into different sizes and automatically discharged into canal boats or carts. Machinery will also be provided for treatment of by-products, for compressing tin into bundles, sorting and baling paper, etc.

Winding Roadway for Steep Street

Lombard street, San Francisco, between Hyde and Leavenworth, has a continuous grade of 27% and has been practically impassable for vehicles. The city has recently carried out the plans of the city engineer and reduced the roadway grade to 16% by winding it back and forth across the street, utilizing the full width of the roadway and a considerable part of that of the sidewalks. In order to carry out the construction of this roadway, it is necessary to build retaining walls on the downhill side of each diagonal course of the roadway. The roadway in banked at each turn.

While short lengths of street have been treated in this manner before, this is believed to be the first instance where the full length of a block has been developed in this way. The residents of the street are planning parking the areas between the curves of the roadway and installing ornamental electroliers. The sidewalk probably will be provided with vitrified brick steps alternating with inclined walks, while ornamental seats will be placed in the parked areas.

WINDING ROADWAY ON LOMBARD STREET, SAN FRANCISCO

Rubber Pavements in England

Experiments with rubber pavements are being carried out in Manchester by a firm which has been using rubber for floors and other purposes for the past forty-five or fifty years. Instead of making the pavement in blocks, large slabs of rubber two inches thick are to be used, each slab weighing about 600 pounds, so that the possibility of creeping or lifting which has been experienced in previous attempts will be reduced to a minimum. The surface is corrugated, giving the appearance of small blocks and supplying a safe foothold for horses. The slabs are reinforced at intervals with steel bars which keep them rigid. These slabs are placed on a concrete foundation and the joints are cemented with tar.

According to "Indian Engineering," an experiment has been made in Colombo with paving a road with a mixture of rubber, mexphalte and picaleum, which proved to be a failure; but another somewhat similar preparation was reported as very successful, this being said to consist of a mixture of pure bark and scrap rubber. It resembles tar and is delivered in solid form in barrels and is applied to the road by heating until liquid and spreading with brooms, after which fine gravel is sprinkled on the surface and lightly rolled.

Charleston, South Carolina, backfills trenches as well as repaving over them. The contractor who opens the street notifies the street department before 2:00 p. m. of the day when he is ready for backfilling. The city's backfilling gang is then sent and refills the trench, ramming in 6-inch to 8-inch layers. The foreman of the backfilling gang reports when this work is completed, giving the yardage of backfilling done. The party for whom the trench is filled is charged 80c. per cubic yard if the fill amounts to 15 cubic yards or less and 40c. if it amounts to more than that.

PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 54 June, 1923 No. 6

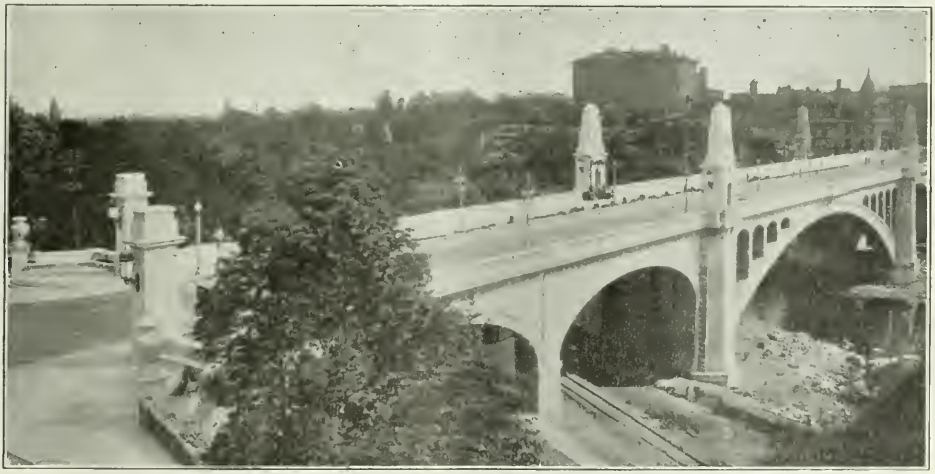
Wilmington's Memorial Bridge

A reinforced concrete structure, notable for rational design, exceptional arch proportions, strength, capacity and harmonious decorative features.

By Frank W. Skinner, M. Am. Soc. C.E.

On Decoration Day, May, 30, 1922, impressive ceremonies marked the formal dedication to the Delaware soldiers and sailors of the Nation's wars, especially the World War, of a bridge across Brandywine creek in the city of Wilmington, Delaware. The bridge is not only a memorial structure but is of great practical service, carrying important vehicular traffic of the Washington Boulevard. It demonstrates that grace, strength and durability are obtainable by concrete arch design at a cost less than the ultimate expense for the building and maintenance of an alternative, minimum cost, all steel structure that is solely utilitarian.

On March 31, 1919, the Governor of Delaware approved an Act of the General Assembly authorizing New Castle county to issue bonds for the construction of a new bridge across the Brandywine at Washington street and naming a commission to carry out the purpose of the Act. The commission with Alfred I. DuPont as chairman, was organized shortly afterward and appointed Frederick W. Carpenter of New York to act as executive officer and consulting engineer of the commission, and promptly invited several reputable bridge engineers to submit competitive designs for the bridge. Each competitor was furnished with a set of plans of the existing old steel structure together with a profile of the site and the proposed length and width (60 feet to 63 feet) of the new bridge and was asked to submit with his design an estimate of the cost of same. It was provided that each competitor would receive $500 as payment in full



VIEW OF WASHINGTON MEMORIAL BRIDGE FROM BRANDYWINE PARK.
Showing the general proportions of the structure, together with the architectural treatment of the north portal and the main pylons, upon the faces of which the memorial tablets of bronze are mounted.

for his services in the event that his design was not accepted by the commission, and that the commission would enter into a formal engineering contract with the competitor submitting the accepted design.

On August 14th, out of ten designs submitted, that by Benjamin H. Davis, of New York City, in the preparation of which Vance W. Torbert, architect, had collaborated, was selected by the commission.

The approved design was selected entirely on its merits, the estimated cost—$594,769 for a bridge 63 feet wide—was the highest submitted by any of the engineers competing.

On August 23, the commission entered into a memorandum of agreement with Davis and Torbert, at the customary engineering and architectural fees, providing for the preparation of all necessary plans and drawings, form of contract, bond and proposal, and for complete supervision during the construction of the bridge.

About the end of November the commission ordered plans prepared for a bridge 82 feet wide instead of 63 feet wide and bids for this wider structure that were received on January 26, 1920 from four contractors varied from a minimum of $800,816.30 for all concrete to $1,753,279.80 for concrete with granite facing.

The design was then revised to provide a bridge 72 feet wide and the lowest bid submitted by the contractor who eventually received the award was $747,743.15. The extra cost of precast stone work subsequently ordered by the commission brought the cost of the completed bridge to a total of $751,980.91 exclusive of engineering and the administrative expenses of the commission.

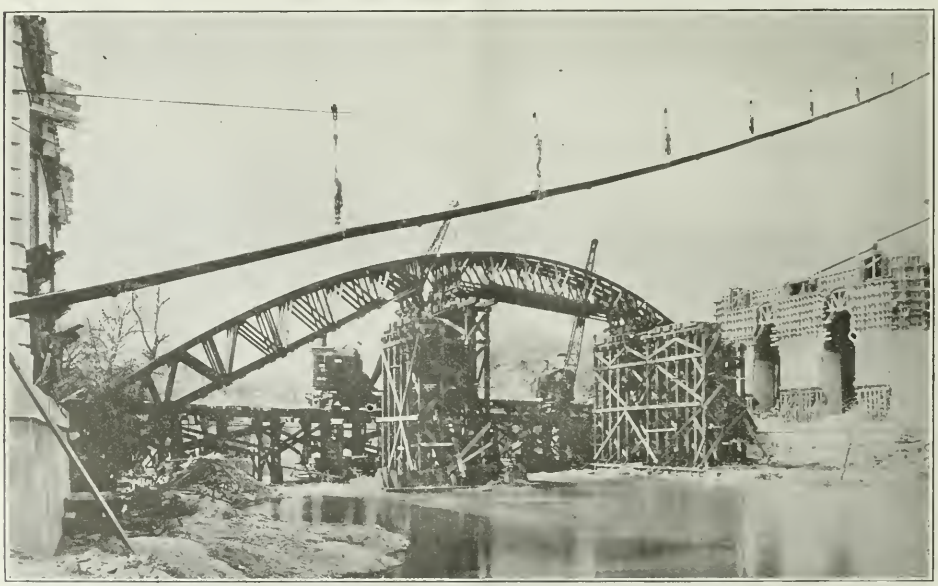
THE BRIDGE DESIGN

The bridge, which is built on a skew of 30 degrees, is 734 feet long and 72 feet wide over all, with a center height of 65 feet from the high water level of the creek to the top of roadway. It has two 16-foot sidewalks proportioned for a live load of 100 pounds per square foot and a 40-foot roadway with two trolley tracks, each designed to carry trains of 60-ton electric cars, 60 feet long. Two full lines of 20-ton motor trucks with 12-foot wheel bases were also assumed as part of the live load, for which an impact allowance was made according to the formula:

$$\text{Impact} = \frac{\text{Live Load}^2}{\text{Live Load} + \text{Dead Load}}$$

The arch rib strains were computed by Cain's elastic theory and the arch rings were proportioned for total combined stress—dead load, live load, ring shortening and temperature—not exceeding 750 pounds per square inch in the arch ring masonry. The reinforced concrete floor slabs and beams of the structure were also proportioned for maximum stresses of 750 pounds compression per square inch in the concrete and 16,000 pounds per square inch tension in the reinforcing steel.

Very careful study was made to develop a design for the bridge in harmony with the natural features of the site, including canals, railroad and park driveways, in order to make the bridge an impressive and beautiful feature of the landscape.



STEEL CENTERING IN PLACE FOR FIRST RIB OF 250-FOOT SPAN.
Showing the three-span steel centering before the lagging and side forms had been erected, and also the wooden falsework towers supporting the centering from bed rock in the stream bed.

A structure having five arch spans symmetrically balanced with respect to the creek was selected from numerous concepts as combining in the highest degree the structural, artistic, architectural and engineering advantages and possibilities of the bridge site, and the monumental and memorial features of the bridge were developed from the large central span as a primary motif. The massive center piers are surmounted by ornamental pylons 40 feet high, and smaller pylons command the bridge portals. Refuge bays are provided on both sides of the bridge at the center of the main span, and at the end of the structure, and the handsome balustrade of Onondaga Litholite is embellished with large ornamental urns at the extremities of the refuge bay at the north end of the bridge. A graceful stairway leads from the south end of the bridge to the park sidewalk below.

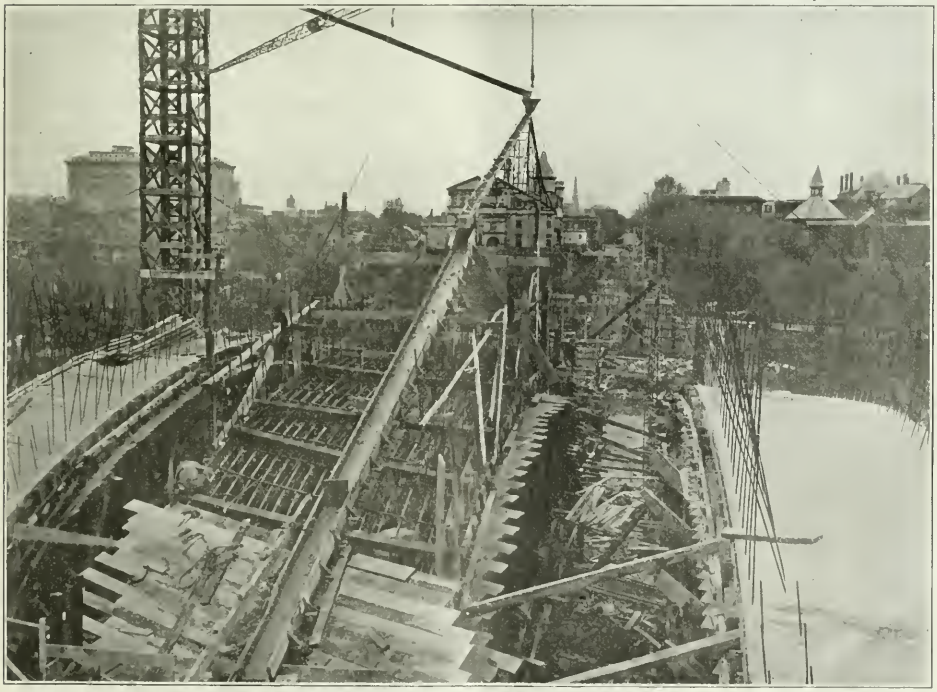
The bridge is lighted by twelve 250-candle-power incandescent lights in bronze bracket lanterns on the pylons and by twenty-eight 600-candle-power arc lights on ornamental metal posts set on the curb lines.

While the character and design of the entire bridge is of a decided memorial nature, the distinctive memorial features are embodied in four large bronze tablets placed on four monumental pylons or shafts, each tablet being 9 feet high by 5 feet wide. The first two of the large tablets commemorate all of the wars of the nation, and the last two tablets commemorate the World War, one having the names of the great battles in which Delaware troops fought and the other bearing the names of all those service men from the entire State of Delaware who made the supreme sacrifice.

Two channel piers, each 20 feet wide, shore piers 8 and 9 feet wide respectively, and two abutments support the 250-foot center span with 40-foot rise, two 70-foot spans with 15-foot rise, and two 85-foot spans with 18-foot rise. Each arch has a center rib 16 feet wide and two outer ribs 5 feet apart on centers, that are each 11 feet wide.

The center rib of the 250-foot span is 6 feet deep at the crown and 11 feet at the springing line and the outer ribs are 5 feet and 10 feet deep, at the crown and springing lines, respectively.

Over each of these arch ribs and immediately under the floor slab there is a continuous gallery, one of which is reserved for high tension electrical conduits, the second for low tension electrical conduits and the third for gas and water mains. The reinforced concrete floor slab, varying from 12 to 20 inches in thickness, exclusive of floor beams (which occur only at the expansion joints), is supported on longitudinal walls. These longitudinal bearing walls rest directly on the extradoses of the shore spans and are supported by the spandrel columns of the channel



POURING THE MIDDLE RIB OF AN APPROACH SPAN.
Showing one tower and counterweighted swinging boom of the spouting system employed in placing concrete.

span. The floor slab is arched transversely between ribs, and is cambered 12 inches to a parabolic curve longitudinally.

The foundations of all piers and abutments were carried down to solid rock at a maximum depth of 5 feet below water level.

CONSTRUCTION

Plant and materials were delivered to both sides of the creek over two sidings from the Brandywine branch of the Philadelphia, Baltimore and Washington Railway, which passes under the bridge. The contractors installed a service track on a temporary trestle crossing the creek, parallel and adjacent to the bridge. The concrete plant was established on the north side of the creek, where aggregate and cement were stored and a concrete mixer installed that delivered to the hoisting bucket of a wooden tower 210 feet high equipped with a steel chute supported by the tower boom and a counterweighted cantilever truss. From this wooden tower, concrete was spouted to the adjacent spans of the bridge and to the foot of an auxiliary steel tower 160 feet high on the opposite side of the creek, where it was re-hoisted and spouted to the other portions of the structure, a system of distribution that was well adapted to the conditions and proved sufficient and satisfactory.

VIEW BETWEEN RIBS OF THE 250-FOOT ARCH SPAN.

Showing the beamless floor slab construction and the expansion joints in the roadway slabs, giving a fair idea of the general appearance of the structure from below.

The best monthly record of concreting was 2,245 yards and the maximum output of the mixer was 282 yards in one working day. The total amount of concrete placed was 17,278 yards, of which 8,545 yards at $34 per yard was used for the arch rings and floor slabs, 2,443 yards at $25.50 for the spandrel walls, and 5,804 yards at $20 for the substructure, besides 485 yards at $35 for the pylons. The concrete was reinforced by 972,800 pounds of corrugated bars at 7 cents per pound in place.

All of the forms were built of wood, of simple standard construction and, with the exception of some of the floor slab forms, were used only once. The materials used in the arch centering, however, were used again and again in building centers and forms for subsequent spans. The pier forms were constructed in large panels for the full height of each pier from footing to under coping lines and the pier concrete was poured continuously and as rapidly as convenient at a maximum rate of about 23 feet vertically per day.

The piers were made in separate sections for each rib, the sections being independent for the short spans, but connected by curtain walls to give a more massive, monolithic appearance for the channel piers. The arch ribs for each of the 70-foot and 85-foot shore spans were successively concreted in wooden forms supported by timber centering consisting of vertical and inclined posts seated on heavy, longitudinal sills carried by transverse double bents of framed falsework.

The large 250-foot arch of the channel span was supported during construction on steel truss centers built with curved top chords to conform to the curve of the soffits of the arch rings. These steel centers were supported on two wooden towers erected in the bed of the creek, and on blocking at the springing lines. The wooden falsework towers consisted of two pairs of bents thoroughly braced together that were wide enough, parallel to the axis of the creek to reach from side to side of the bridge. The centers were made of a width sufficient to serve for the construction of one rib and were then lowered slightly and moved laterally into correct position to serve again and again for each of the other two ribs. These centers were erected by a locomotive crane operating from a service track parallel to the bridge. A wooden nailing strip of variable thickness was bolted to the curved top chords of the steel centers to provide suitable bearing and support for the 4-inch yellow pine, tongue-and-groove lagging used to form the arch soffits.

The main arch ribs were poured in alternate blocks and keys, each completed in one continuous operation. Each rib contained nine blocks 25 to 27 feet long, the intermediate keys having an approximately uniform length of 4 feet. When the arch ribs were at least 28 days old, the centers were struck by slacking the wedges under the bearings of the falsework trusses, and the

maximum deflection noted was ¼ inch for the short spans and ⅝ inch for the long span.

After the spandrel walls and upper portions of the piers had been concreted, the floor slab forms were set and concreted for the successive spans, each section between expansion joints being concreted in a single operation to make a continuous, monolithic slab.

The deck of the bridge and the backs of all retaining walls and abutments were waterproofed with a membrane consisting of two-ply cotton fabric saturated with asphalt, protected by a thin layer of concrete. All expansion joints were flashed with copper and caulked with oakum and asphaltic expansion joint cement.

STAIRWAY AT SOUTH END OF BRIDGE.
Showing granite composite balustrades connecting the sidewalks of the bridge with that of the park driveway below.

The exposed surfaces of the arch ribs, piers, abutments and spandrel walls were carborundum rubbed at a cost of 10c per square foot, and the pylons and balustrades were bush hammered at 15c per square foot.

The Onondaga Litholite balustrades, shields, urns, eagles and pylon caps cost $36,775, and the bronze lighting fixtures, memorial tablets, name plates and ornamental lamp posts cost $19,880.

All of the concrete was made with Lehigh portland cement, of which 27,104 barrels were used; Delaware river washed sand, of which 10,537 tons were used, and Brandywine crushed granite of which 21,074 tons were used in the construction of the bridge.

The bridge was built by an average daily working force of 50 men and a maximum force of 85 men, working under the direction of H. K. Wilson, resident engineer for B. H. Davis. David Small, eastern manager, and E. C. Heber, superintendent, were in charge of the construction operations for the general contractors, the Walsh Construction Company of Davenport, Iowa.

Cost of Paving in Charleston

Charleston, South Carolina, laid 19,736 square yards of sheet asphalt last year at the following unit prices: Grading 5c. per square yard, 4-inch concrete base 89c., 5-inch concrete base $1.08, 6-inch concrete base $1.22, 1½-inch binder 45c., and 1½-inch top 44c. Four thousand six hundred and four square yards of creosoted wood block was laid along rails for $2.63 per square yard, the blocks being 3 inches deep and having received 16 lbs. treatment. These prices do not include tearing up and hauling away old granite blocks, vitrified brick and cobblestones from the old pavement, nor hauling in material necessary for bringing up the grade, but these were done as special items in the bid.

VIEW OF THE COMPLETED MAIN ARCH.

Treatment of Laundry Wastes

Condensed abstract of report on an investigation by Pennsylvania Department of Health.

By F. E. Daniels*

In order to obtain data upon which to base advice and approval of plans for treatment of laundry waste in places not provided with sewerage systems, the Engineering Division of the Pennsylvania Department of Health conducted a series of laboratory tests and field observations on wastes from steam laundries in Harrisburg and at one of the state sanatoria.

LABORATORY WORK

Sulphuric acid was used to bring the hydrogen ion concentration near the iso-electric point in order to facilitate precipitation. This was found to be exceedingly effective; for, when by the addition of sulphuric acid the solution was brought to the proper pH on the acid side of neutrality and then the solution made slightly alkaline with lime, an immediate coagulation and precipitation of the suspended and colloidal matters occurred, and a perfectly clear and sparkling supernatant liquor was instantly obtained. When such a mixture was placed on a filter paper the filtrate ran through as rapidly as clear water.

The Mont Alto Experiments.—The steam laundry at the Mont Alto Sanatorium is well equipped with modern machinery and the wash of approximately one thousand people is handled by it. Two toilets in the building discharge into the sewer so that in all respects the daily waste from the plant closely resembles that from any modern steam laundry. In passing it may be said that the presence of a moderate amount of toilet sewage seemed to have no effect upon clarification although a large percentage would no doubt demand some form of biologic treatment subsequent to the chemical precipitation.

The treatment plant consisted of barrels holding 50 gallons each, arranged in tiers, so that the discharge from the upper tier flowed into the lower and from the lower into half-barrels filled with sand to act as sand filters. Two sets or units were provided, one for the acid-lime method and one for parallel runs with iron sulphate and lime for comparison. In the upper tier two extra barrels served as reservoirs for milk of lime and iron sulphate solution respectively. Nipples of half inch pipe with stop-cocks and short pieces of rubber hose afforded convenient means for dosing and regulating flows.

The method of operation was as follows: The upper barrel of each unit was pumped full of laundry waste.

One hundred cc. of the waste was put into a glass tumbler and a small quantity of thymol blue indicator solution added. Then dilute sulphuric acid (1:5) was added drop by drop until the indicator changed to a faint orange color. This increased the hydrogen ion concentration, or, as we say, lowered the pH to about 2.6.

By means of a table, previously prepared, the amount of dilute acid required for 100 cc. showed the number of cc. of concentrated acid needed for the barrel, which, when measured out, were put into the barrel and its contents stirred.

The reaction being so rapid enabled the process to proceed immediately, allowing the acidulated waste to be discharged into a small much baffled mixing trough resting on the top of the lower barrel. At the same time a small stream of milk of lime was allowed to enter the trough and mix with the acidulated waste, the amount of lime being so regulated that the discharge from the trough showed only a faint pink with phenolphthalein indicator.

The discharge from the mixing trough dropped into a piece of 4" pipe suspended vertically in and reaching nearly to the bottom of the so-called lower barrel which acted as a settling tank. The coagulation and precipitation being so rapid and complete, the upward current was not sufficient to bring up suspended matters and the discharge from the top or overflow of the settling barrel was always perfectly clear, rendering the use of the half-barrel sand filter unnecessary for clarification.

Rates of flow up to the capacity of the nipples and stop-cocks were used which approximated less than 15 min. detention periods for settling.

For comparison 100 cc. of waste from the other unit were taken and tried with iron sulphate solution. From the amount required for 100 cc. the amount for the barrel was calculated and added. The mixture was then run into its settling barrel along with sufficient milk of lime to give a faint pink with phenolphathalein. The settling required about four times the period of detention as the acid-lime method, was not so easily controlled, and when the effluent was run upon the sand filter there was a tendency for it to clog and cake. The sand filter effluent, however, appeared perfectly satisfactory.

On account of cool weather the effects of the effluents in streams in mid-summer could not be definitely ascertained; but samples inoculated with sewage and kept at room temperature for seven days did not develop odor or show signs of decomposition. The effluents from the experiments were allowed to run to a nearby ditch and accumulate for a month. They showed no objectionable conditions whatever.

There was, however, in the samples analyzed quite a biochemical oxygen demand and it is possible that bacterial action was inhibited by the excess lime. For that reason unless biological filters are used, the discharge into streams should be in such a manner as to ensure quick dispersion into the diluting water, otherwise the discharge might give rise to organic growths such as are to be observed in streams receiving lime precipitated sewage.

Acid-Alum Method. — Sulphuric acid was added to the laundry waste to lower the pH from about 12.0 to about 7.0 using brom-thymol-blue indicator. Having determined by experiment the minimum satisfactory amount of alum to cause clarification, the proportionate amount for the quantity of water treated was added.

This addition caused a heavy precipitate which settled in 5 minutes to nine per cent. of the total volume, and in 12 hours to five per cent. of the total volume.

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The filtrate was clear, the colloidal suspensions having been removed, the total solids reduced about 70 per cent., the volatile matter lowered about 80 per cent., and the fixed residue reduced about 66 per cent.

The addition of alum further reduced the pH from 7.0 to about 6.0, but upon escapement of the CO_2 formed by the reaction the pH gradually rose to 7.0 or a little over. It is therefore desirable to remove the precipitate before the solution becomes sufficiently alkaline to redissolve any of the aluminum hydrate.

Cost of Treatment.—On the composite waste used it was found that 2.1 pounds of sulphuric acid @ 1.8 cents per pound and 2.8 pounds of alum @ 1.25 cents per pound were required for 1000 gallons, thus making a total cost for chemicals of 7.3 cents per 1,000 gallons.

SUMMARY

The principles of the clarification of laundry wastes are:

1. Correct alkalinity and adjust with acid to pH 2.6 for lime or pH 7.0 for alum.
2. Precipitate with lime or alum.
3. Settle; run off clear supernatant liquor.
4. Draw off sludge and dry on sludge bed.
5. Iron sulphate and lime may be used in place of acid and lime.
6. Comparative costs of clarifying chemicals per 1,000 gallons of waste are: acid lime method, 28 cts; iron lime method, 24 cts, and acid-alum method, 7.3 cts.

CONCLUSIONS

From the foregoing the following conclusions may be drawn:

1. The laundry wastes for the day should be mixed and the flow equalized so that treatment can proceed at a uniform strength and rate.

2. Sulphuric acid may be added to the waste as it enters the equalizing tank, or to the uniform discharge from the tank, the amount depending upon the process used.

3. Instead of sulphuric acid iron sulphate may be used, if that method is to be employed.

4. Milk of lime may be added in the mixing trough leading to the settling tank.

5. The settling tanks need have only 15 minutes detention for the acid-lime method or 1 hour for the iron-lime method.

6. Subsequent treatment on sand filters may be made if it is desirable to do so.

7. Alum may be substituted in the mixing trough in place of milk of lime.

The author wishes to acknowledge and give credit to Edward Martin, M. D., C. A. Emerson, Jr., and W. L. Long, who, at the time of the above work were respectively Commissioner of Health, Chief Engineer and Chief Chemist. Also to present Chief Chemist and Assistant Chemist D. P. Rogers and C. R. Lowe.

Marl for Softening Water

A bulletin issued by the Bureau of Conservation and Development announces that a market may possibly be developed for the use of green sand marl, of which there are large deposits in the southern part of New Jersey, for softening water. The bulletin states: "After certain preliminary treatment, which charges it with exchangeable sodium, the marl is placed in the water softener and the water allowed to flow through it in a manner somewhat resembling the ordinary filter. The exchangeable sodium of the treated marl combines with the calcium and magnesium, the cause of hard water, and in turn gives up a proportionate quantity of sodium to the water. To restore it to complete efficiency it is only necessary to pass a solution of brine through the apparatus.

Progress on the Wanaque Project

In driving the Great Notch Tunnel full use is made of the most up-to-date labor-saving machinery. Description continued from the May issue.

RIVER CONTROL CONDUIT

The river crosses the line of the dam at the extreme south end of the core wall, and this end has been omitted to permit the flow of the stream. Work has now been begun on the construction of a double-barrel control conduit to carry the flow of the stream during the completion of the core wall. There will be two conduits, one slightly lower than the other, it being proposed to carry the ordinary flow of the river through the lower, while the other will come into use during floods. Except when the upper is carrying flood water, it will probably be used for carrying materials from one side of the dam to the other, probably by laying a track in it and running construction trains through. Later on, it is possible that a hydro-electric power house will be located below the dam and water supplied to it through these conduits; although this point has not been finally decided, as it will depend upon the decisions made as to use of water by various municipalities.

For the time being an ingenious method has been adopted for using an ordinary derrick stationed on the north bank of the river for excavating the bench for the control conduits on the south bank at a point about 200 feet away and bringing the excavated material on to the north bank where there is room for depositing it. A derrick with a 70-foot boom carries a block on the end of the boom through which is rove a cable with one end wound on one of the drums of the engine and the other end carried across the river where it is fastened to a deadman. Suspended from a block that travels on this cable is a bucket used as dragline bucket, the cable for dragging it being wound on another drum of the engine. With the empty bucket on the derrick side of the river, by taking up slack in the main cable the north end of it is brought to an elevation of about 60 feet above the ground while the south end is only 10 feet or so, and the bucket then travels by gravity to the south side of the river, dragging its cable with it. Then, by slacking up sufficiently

on the main cable and pulling on the drag cable, the bucket acts as a dragline bucket and, by taking in or letting out on the main cable while pulling in on the drag cable, the bucket can be delivered on the north side of the river at any elevation desired, emptied into a dump car and then, by taking up the slack on the main cable, it returns to the south side again.

THE TUNNEL.

The tunnel, which is known as "Great Notch Tunnel," is to be 9,100 feet long followed by 80 feet of aqueduct in rather deep cut and another short tunnel passing under the highway, a few feet south of which is the main portal. It is possible, however, that the contractor may continue the tunnel construction the entire distance between portals, making the tunnel about 9,300 feet long. The tunnel passes under two railway tracks immediately after leaving the north portal and under another track and four highways, while the line passes comparatively close to the large Cedar Grove reservoir of the Newark water supply, to the buildings of the State Normal School and to a large cemetery. The greatest depth below the surface is slightly over 300 feet. It is not contemplated to sink any shafts, but the entire length of the tunnel will be driven from the two portals. The north tunnel is now in about 900 feet and work is beginning on the open cut leading to the south portal.

The contract also includes a northly approach of 625 feet of concrete aqueduct built in open cut and a southerly approach of 7,325 feet of aqueduct in open cut. In the former is a short section of reinforced concrete siphon by which the aqueduct is carried under two 72-inch steel pipes of the Jersey City water supply system, and in the southerly approach 675 feet is in the form of a reinforced concrete siphon under the Yantecaw river. At each end of the contract, connection chambers are to be built for connecting this work with other contracts.

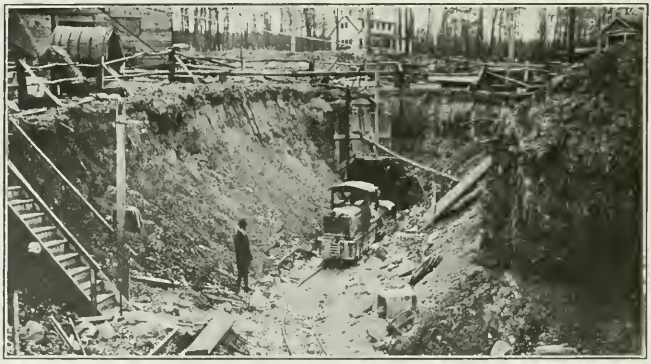
In section, the tunnel will be of horseshoe shape, 7 feet high and 7 feet wide, the invert having a radius of 7 feet, the semi-circular arch a radius of 3 feet 6 inches, and the lower part of the side walls a radius of 7 feet, all inside dimensions. The aqueduct in open cut is 7 feet high and 7 feet 2⅛ inches wide. The Yantecaw siphon is circular with a radius of 3 feet 6 inches, 7 inches thick at the crown, 10 inches at the invert and 12 inches at the spring line; the reinforcement being placed 3½ inches from the inner surface and consisting of ⅜-inch square rods spaced at intervals varying with the depth of the siphon. The siphon under the 72-inch steel pipes is of practically the same construction. In the tunnel the A line of rock excavation, within which no rock must extend, is 5 inches from the inner surface of the finished tunnel, while the B line, or that to which excavation payment is made, is 14 inches from the inner surface.

About two-fifths of the length of the tunnel, at the north end, is in trap rock or true Basalt, while the southern three-fifths is in shale and sandstone.

Separate prices will be paid for the traprock and for the sandstone, respectively, the specifications classifying as sandstone anything which is not properly traprock and providing that any difference of opinion on this point between contractor and engineer shall be finally decided by the State geologist of New Jersey. The traprock can be used by the contractor for concrete and presumably will be, but the use of sandstone is prohibited.

It is expected that more or less ground water will seep into the tunnel, but it is proposed to make the concrete lining perfectly watertight. The contract accordingly provides that large inflows shall be stopped by construction of vented special concrete bulkheads in advance of the tunnel lining; by placing drains of timber or pipe under the invert where necessary, openings being left in the invert at intervals for closing the drains with concrete or grout later on; and sheet steel pans are to be installed over seeping rock and elsewhere to prevent water from injuring the concrete while it is being placed or setting, these pans being supported by nailing them to wooden plugs driven into holes drilled in the rock and calking between the edges of the pan and the rock and connecting the pan either to the invert drain or to vent pipes that will lead the water through the concrete. Small water-bearing crevices are to be calked, blind drains be used to lead water away from springs in the invert, steel pans or other suitable devices are to be installed to prevent water from dripping on to concrete while it is being placed, and, in general, such bulkheads, dams, sumps and pumping equipment are to be installed as is necessary to keep water out of the excavation while concreting.

The contractor is permitted to use either electricity, compressed air or hydraulic power in the tunnel, but not steam; and provision must be made for ventilating the tunnel. The contractor is using air for drills and for running a mucking machine and is using storage battery locomotives for hauling



Courtesy Newark Evening News.

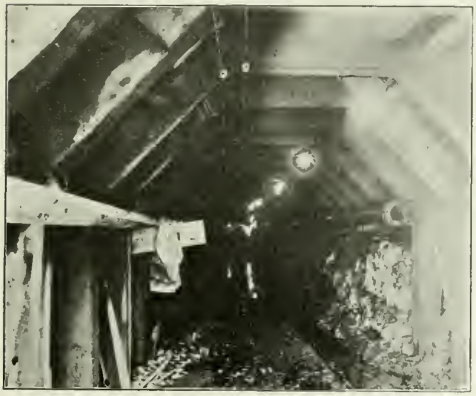
TUNNEL ENTRANCE, NORTH PORTAL.

the mucking cars. Ventilating air is provided by means of a blower.

The contractor for the tunnel is Heyman & Goodman, of Jersey City. The total of the itemized bids used as a basis of awarding the contract was $918,267.

Owing to the small size of the tunnel, only about 9 feet high and wide, the entire heading is blown at once. Twenty holes are driven in the heading, using three Water-Leyner drills. The holes are charged with six pounds of Atlas 60% powder per cubic yard and are fired in six successive shots. Drilling is performed in two shifts, and after firing at the end of each shift, the mucking is performed.

For mucking, the contractor is using a Hoar mechanical shovel, which is found to work satisfactorily in this small tunnel. It consists of a bucket arm and bucket, which is slid forward and downward until the bucket rests upon the ground at the base of the muck pile when, by pulling on the upper end of the arm, which is pivoted near the center, the bucket is crowded into the muck pile. When filled, the bucket is raised, the arm moving into a horizontal



Courtesy Newark Evening News.

TUNNEL FROM NORTH PORTAL, SHOWING TIMBERING.

position, lying on top of the car. The car revolves through the entire circumference on a turntable and the bucket can, therefore, be brought over a mucking car at either the side of the shovel or in the rear thereof. The lowering, raising and crowding are performed by means of chains and short cables, compressed air being used for operating the mechanism. The operator sits in a seat alongside the car. The total height to the top of the operator's head is less than 7 feet, and the shovel can operate and revolve within a width of 7 feet or 7 feet 6 inches. One of these shovels is already in use at the north portal and another is in place for use at the south.

Owing to the narrowness of this tunnel, it is not possible to run two tracks or even a siding in the tunnel, nor to provide a switch by which mucking cars can be spotted alongside the shovel. The contractor has, therefore, provided behind the shovel a portable conveyor onto which the shovel discharges the muck, which conveyor overhangs its carriage

Courtesy Newark Evening News.

DRILLING HEADING OF TUNNEL.

sufficiently far to discharge the muck into the middle of a 3-yard, side-dump, narrow-guage car, which is spotted under it. This car is hauled by a storage battery locomotive built by the Atlas Car & Mfg. Company especially for service in a small tunnel of this kind.

At each portal the contractor has installed a plant for furnishing compressed air, electricity, etc., for the various mechanisms. Each plant is operated by a 165 h.p. semi-Diesel engine made by the Anderson Manufacturing Company, which uses ordinary fuel oil, Texaco fuel oil being used on this work. This engine drives a shaft which in turn drives by belt a large air compressor, a dynamo, a pump, and a blower, Hill clutches being used to throw the power on and off each of these. A small auxiliary engine provides compressed air for the starting tanks. The compressor is an Ingersoll-Rand "Imperial" type 10. A General Electric dynamo provides current for lighting the tunnel and the several buildings; the blower is a Connersville and provides the air for ventilating the tunnel. The pump is a small one used for circulating the water for cooling the compressor.

The oil used by the plant at the north portal is stored in a tank holding about 11,000 gallons set so as to feed the engine by gravity, while the tank itself is about 200 feet from and several feet lower than a branch of the Erie Railroad, and can readily be filled by gravity from a tank car. Air from the compressor is used by the blacksmith as well as for operating the drills, the mechanical shovel and some other equipment. The engine has been run continuously since February 1st, stopping from Saturday night to Monday morning only, except on two or three occasions when emergencies outside of the engine itself required it.

About 55 or 60 men are employed at present in the tunnel work. Most of these live in the vicinity of the work, so that it has not been necessary for the contractor to house any of the labor, although provision has been made for this.

The tunnel work has progressed at the following rates, in lineal feet of tunnel, per week: For the week ending April 14, 44 feet; April 21, 57 feet; April 28, 69 feet; May 5, 79 feet; May 12, 74 feet; May 19, 73 feet; May 26, 74 feet; June 2, 69 feet. Prior to April 7 about 450 feet had been tunneled

at rates of 16 to 67 feet a week. Most of the time, up to the first of May, an oil locomotive had been used to haul the cars, but since about May 7 the storage-battery locomotive has been used instead. The mechanical shovel was first put into operation a short time before this. The average rate of progress since April 21 involves the removal of 170 cubic yards of rock a week, or about 15 yards a shift.

On the tunnel work, Robert Parker is general superintendent for the contractor and J. A. Ward is assistant engineer on the tunnel for the Commission. At the Wanaque Dam, W. H. Gahagan is the contractor, with R. C. Young as his superintendent. Major A. H. Pratt is chief engineer for the Commission and M. R. Sherrard is consulting engineer, while N. C. Holdredge is assistant chief engineer in direct charge of construction of the entire project. The Commission consists of Lourent J. Tonnele, chairman; Wood McKee, Obadiah C. Bogardus and Thomas L. Raymond.

The Writing of Engineering Reports*

This is of importance to the engineer second only to ability to handle men. Information to be included in report, method of presenting it, and form of report.

By Nathan C. Grover, M. Am. Soc. C. E.†

Next to ability in handling men, the success of an engineer probably depends more on his skill in writing clear, concise, and comprehensive reports than on any other factor. After many years in a position which necessitates the review of numerous reports by engineers engaged in both governmental and private organizations, the writer is forced to conclude that engineering schools are giving too little consideration to this important factor in an engineer's training and are thereby overlooking one of their important duties to the engineering world.

Report writing differs as much from popular writing as does mechanical drawing from works in water colors or oils. While only a few gifted persons may become noted authors or artists, it is exceptional that an engineer can not readily train himself to make creditable mechanical drawings, and similarly to prepare meritorious reports.

In writing a report the engineer should give proper attention to a study of (1) the purpose of a report, (2) the information to be included, (3) the method of presenting the information, and (4) the form of the report.

The duties of an engineer extend beyond his study of the physical features relating to an enterprise and include questions of administration, operation, economics, and finance, and even questions pertaining to the relation of the enterprise to the community. An engineering report, therefore, may and often must discuss all these related factors on which success may depend.

Broadly, the requirements of a successful reporting engineer are:

1. To see and evaluate possibilities.
2. To formulate features of design.
3. To estimate with reasonable accuracy the cost of construction.
4. To analyze and to appraise properly the market, industrial and social conditions.
5. To prepare a clear and concise statement covering the essential features of a project.
6. To draw sound and definite conclusions.

*From "The Cornell Civil Engineer," Vol. XXXI, No. 6.
†Chief Hydraulic Engineer, U. S. Geological Survey.

PURPOSE OF A REPORT

Engineering reports may be divided into two classes—administrative and technical.

The object of an administrative report is to present information in regard to progress or status of investigations, development, or operation, in order that interested persons may be informed of its progress and that a permanent record may be made of the condition of the work at stated intervals of time.

A technical report may pertain to investigations of a project, to its development, to the operations of a going concern, or to a completed structure. Its object may be to present the important facts and conclusions pertaining to the physical or financial practicability of a project or to the economics of a going concern, for the consideration of persons interested in the construction, operation, financing, or control of the enterprise; or the report may be made primarily to record permanently the information obtained.

INFORMATION TO BE INCLUDED IN A REPORT

An administrative report should contain statements in regard to personnel, finances, progress of work, and like features, or to the factors and conditions affecting these features. If lengthy discussions of details are necessary, they should be presented in separate reports or appendixes.

Technical reports should contain statements of the technical and related features of the project or development and the conclusions derived from the statements. Every report should include—

1. An introduction stating the object of the report and giving a general description of the project or development and the sources of information.

2. A presentation, in the body of the report, of all important facts necessary to show the physical characteristics, feasibility, and estimate cost of the project, and its value when completed, as well as the elements of stability or of the risk involved, the nature of the presentation depending on the character of the enterprise. Complete statements relative to all factors affecting the project or development should be given, together with sufficient information

to indicate the reliability of the data on which the conclusions rest.

3. The conclusions should show concisely the results of the analysis of the data presented in the body of the report and the recommendations based on those conclusions. The report should be dated and signed on its final page, or a dated letter of transmittal, bearing the signature of the author, may be prepared.

Each report should include a title page, a table of contents, a list of illustrations, a list of tables, if necessary, and, if the report is long, an index. Long reports should be prefaced with an abstract of not more than two pages presenting the salient facts and conclusions. Related data or discussions not essential to a clear understanding of conditions but necessary as a basis for statements made in the report or for a detailed and critical analysis should be presented, if at all, in appendixes instead of in the body of the report.

As a basis for writing a report, an outline should be prepared and, to guard against ommissions in estimates, a drawing of this or a similar enterprise showing every possible variation should be followed.

METHODS OF PRESENTING INFORMATION

Information can be presented in three forms—text, tables, and illustrations.

All data to be used in the report should be carefully studied in order to determine which of these three forms affords the clearest and best method of presentation. Choice should be made primarily from considerations of conciseness and clearness, but the ability of the probable readers of the report to understand one or the other of these forms must also be considered.

Text.—The matter of the text should be presented in logical order and in simple and concise language. It should be divided into topics designated by center and if necessary by side headings under which the matter should be appropriately divided into paragraphs. Refereneces to information outside the report or to authorities cited should be made by footnotes. Citations of data within the report should be made by cross references, giving page numbers. Direct quotations should be exact as to wording, but errors in punctuation and other obvious printer's errors should be corrected. Proper credit for quotations, either direct or indirect, should be given in the text or in footnotes.

Tables.—Tables offer a convenient and effective method of presenting statistical data and may also be used to present facts that are common to several units or groups, in order to disclose common or special characteristics or to make desirable comparisons. For example, the industrial or other features of the cities of a State may be presented more effectively by grouping them in tables under appropriate headings than by describing them in text.

All headings for tables should be clear and concise. There may be a choice not only as to the wording of headings of columns but as to their grouping as side heads or top heads. A proper choice of these headings may make it possible to combine two tables in one, or to present a table in more condensed and convenient form. A transposition of side and top heads may improve a table both in appearance and in clearness.

Each table should have an appropriate title and in some reports the numbering of tables may increase the ease and definiteness with which references may be made to them.

Illustrations.—Illustrations may be used to amplify the text or tables or as an independent means of presenting information. In general, they may be grouped in two classes—photographs and drawings. Photographs may show either general features or details of specific features. Drawings may be used to present data graphically or plans of features of the work, or, as maps, to show the locality and the positions of important features. A number and appropriate title should appear immediately below each illustration. The title of a photograph should always include the date on which it was taken.

FORM OF A REPORT

All material in the report should be bound in regular book form. The first impression made by a report—a result of its general appearance—may determine its effect on the reader, and the ease with which it can be handled, read and studied—a result of its general arrangement and make-up—may determine to a large extent its value and usefulness.

The manuscript should be typewritten on letter paper, with liberal margins and preferably with no visible corrections either by typewriter or pen. Except for quotations and tables, which may be single spaced, the lines should be double spaced. Pages should be numbered in the upper right hand corner. Tables and illustrations should be inserted in the text at or immediately after the place of first reference to them.

Not only the title page but the first page of text should bear the title of the report and the name of its author. A blank page should precede the title page and follow the last page of the report.

So far as possible, tables and illustrations should be reduced to the size of a page. If this is impossible, the sheet should not exceed twice the height of the page, as only one horizontal fold can be conveniently handled in a bound report. The length, however, is not thus limited as the bellows system of folding permits the ready use of several vertical folds.

So far as possible all drawings should be bound in the report but large sheets that must be folded horizontally more than once may be more conveniently used if placed in a pocket portfolio accompanying the report. A careful study of scales and a proper arrangement of matter may enable the writer to present information on sheets that may be bound in the report. Under no consideration should rolls of drawings accompany a report, as they are inconvenient both for handling and filing.

Automobile Parking

As is the case in many other cities, Toledo is finding the problem of parking on the business streets a most perplexing one. In a recent statement on the subject, Traffic Captain Thomas O'Reilly says that parking on the business streets in that city, partly because of the presence of street car tracks, causes a slowing-up of all traffic, both street-car and automobile, during rush hours, to the great disadvantage of all who are endeavoring to reach their home at

that time. Removing parking from one side of these streets would greatly aid in eliminating this trouble.

Captain O'Reilly states that practically every large city in the country has rules restricting parking in the business districts. Citing a few of these, Philadelphia has no-parking districts as well as fifteen-minute, thirty-minute and sixty-minute limits. Indianapolis bans parking on certain streets. In Cincinnati certain parking stands are established but parking elsewhere in the congested district is limited to sixty minutes. Buffalo has no-parking, one-hour and unlimited parking rules. Columbus has a thirty-minute limitation in the business district. New Orleans rules have sixty-minute, fifteen-minute and no-parking restrictions; Washington, two-hours, thirty minutes and no-parking; Minneapolis, one hour; Chicago, no-parking and sixty minutes; Rochester, no-parking, thirty minutes and sixty minutes.

Salt Water Sprinkling in California

By Charles W. Geiger

The California State Board of Harbor Commissioners uses salt water for filling the street sprinklers along the Embarcadero instead of water from the city mains. For this purpose the Board has installed five centrifugal pumps at various points along the waterfront, each operated by a 5-h.p. electric motor. Pump and motor are placed in a special building at the bulkhead. The suction extends directly into the water and the discharge pipe extends under the sidewalk and is connected to a gooseneck water column used for filling the sprinkling wagons. A hose connected to the water column is inserted into the water tank and the driver of the sprinkler starts the pump in operation by means of a button just inside the pump house opposite the water column, a hand hole in the wall of the house giving access to the button and each driver being provided with a key for opening the door that closes the hand hole. The main door leading to the pump house is kept locked and only electricians employed by the Harbor Board have access to the pumps.

The pump has a 3-inch suction and a 2½-inch discharge and can fill the sprinkler tank in about three minutes. The driver stands at the pump house and, the water column being nearby, can watch the sprinkler and shut off the pump through the hand hole as soon as the tank is filled.

One advantage claimed for the use of salt water in sprinkling is that it eliminates the fly nuisance, in that it is found that flies do not breed where salt water has been sprinkled.

Refuse Salvaging at Eccles, England

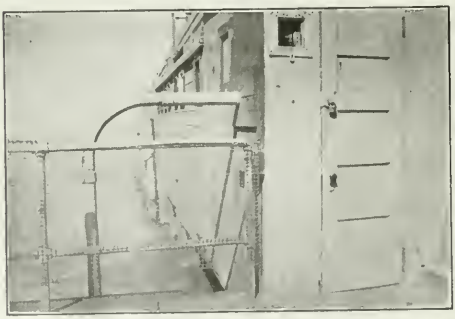
About twenty years ago the Council of Eccles, England, installed destructors for incinerating refuse and used the steam therefrom to operate machinery for pumping sewage at the disposal works. When the population increased from 36,000 to 45,000 the capacity of the plant became insufficient to destroy all the refuse or to pump all the sewage. They thereupon began developing a refuse salvaging scheme which is now in full operation.

At the salvage plant, which is located at the sewage disposal works, the contents of the vehicles are dumped on to a conveyor band which carries the material to a separating screen. The cinders, dust and small matters pass through the screen, while the paper, bricks, cans and bottles are rejected by it and deposited on a picking belt.

The fine material which passes through the screen is carried by another conveyer band to a second screen equipped with a dust jacket screen which separates the dust from the cinders. The cinders thus cleaned are taken by a conveyor belt to two boilers which are hand fed and provide the steam for the pumping plant.

The coarser materials which fall on the picking belt are picked over by hand. The cans are removed separately and baled and continue to find a ready market. Bottles, broken glass, iron scrap, etc., are all sorted and sold. Paper, for which there is no longer a market, and other combustible rubbish, are burned in the destructor furnace.

The new plant supplies, by means of the in-



PUMP HOUSE ALONG EMBARCADO.
Button for stopping and starting pump is just inside the hand hole, which is shown open.

FILLING SPRINKLER FROM WATER COLUMN.
This is across the roadway from the pump house shown in the other picture.

cinerator, all the energy necessary to drive the pumping machinery at the sewage disposal plant and, in addition, showed a net profit last year in fuel value alone of $4,500. In addition, an income was derived from the sale of tin cans, bottles and other salvaged articles. During the year approximately 11,000 tons of house hold refuse was collected, which appears not to have included the garbage.

It is reported that experiments have shown that screened cinders obtained from a given quantity of refuse produce twice the volume of steam obtained by burning the same amount of refuse unscreened, the cinders yielding an evaporation of six pounds of water per pound of cinders, while coal is reported to give an evaporation in the same plant of 8.5 pounds of water per pound of coal.

In disposing by destructor the cost of labor in handling refuse and carting away clinkers is $1.58 per ton (all costs are changed to American money on the basis of $5.00 per pound sterling); the capital charges are 37c per ton; repairs and maintenance, 25c per ton; giving a total cost of $2.20 per ton by destructor. By the salvage method the cost of dumping, screening and destroying combustible matter, including fireman's wages, is 75c per ton; repairs and maintenance, 12c per ton; capital charges on building and machinery, 21c per ton; a total of $1.09 per ton.

Comparing these apparently shows an annual saving in the handling by the salvage method of about $9,000 per year; to which should be added half the fuel value by this method over the destructor treatment, or about $8,000, or a total of about $17,000.

An analysis of the refuse treated at the plant is given as: dust, 40.58%; cinders, 37.6%; debris, 16.16%; paper, 2.9%; tin cans, etc., 1.3%; rags, sacking, etc., 0.84%; broken glass, etc., 0.62%. It is stated that the refuse dirt has a higher value in nitrogen than horse or cow manure, and it is expected that there will be no difficulty in finding sale for it at a price that will cover transportation and other costs.

Pittsburg, California, Sued for Typhoid Cases

A court decision has been rendered against the city of Pittsburg, California, in the amount of $32,821 as damages to citizens who contracted typhoid fever through the medium of its water supply. The bulletin of the California State Board of Health for March, 1923, gives the details of this case and decision.

In June and July, 1920, nearly 150 cases of typhoid fever appeared in the city and investigation apparently established the fact that a short time before raw water from the Sacramento river had been turned into the city mains, the apparatus used for treating it having been out of commission for at least a day. Nineteen persons who contracted typhoid during this outbreak combined in a suit against the city for damages incurred through illness or death, accusing the city of neglect. The result of the case was, as stated above, the awarding of damages, the largest amount to any one individual being $12,500.

In his decision the judge said: "The testimony is to the effect that the chlorinating plant was inoperative during the hours in question by reason of the fact that a drum containing chlorine gas had fixtures that did not permit of ready attachment to the city's pumping system and a special device had to be arranged in order to couple the tank to the suction system of the city's plant. The circumstances of the city's water supply being unwholesome in its raw state, being such as to carry notice of its condition, it was incumbent upon the defendant to use all reasonable precautions to render the water fit and wholesome and to give it such treatment as was necessary to produce such results."

Beccari System of Garbage Disposal

Used in several Italian cities, experimental plant in this country. Utilizes controlled fermentation to produce inodorous, humus-like material.

In the March issue of "PUBLIC WORKS" a brief description was given of the Becarri method of disposing of garbage. Since then further information and a visit to the demonstration plant installed in Paterson, New Jersey, has furnished additional data concerning this interesting innovation in garbage treatment.

The first installation of the system was in Florence, Italy, where in 1914 Dr. Becarri built two cells largely for experimental purposes, although he had previously applied the principle to farms and institutions where manure and other organic matter was transformed into a fertilizer. By November, 1922, 350 cells were in operation in Italy and 1,316 additional cells were either under construction or contracted for.

The system operates by fermentation carried on in cells known as fermentation cells which are usually constructed in groups of two or four as a unit. The functioning depends upon the action of bacteria developed in the fermenting mass. The water draining from the fermenting garbage carries with it great quantities of the bacteria which bring about the fermentation, and this drainage water is mixed with the fresh garbage as it is charged into the cell to cause a rapid development of the desired fermentation.

The cell, with a capacity of about 25 cubic yards, (or smaller where the quantities to be treated are small) has a double floor, the bottom one impervious to moisture and inclined so as to lead away the drainage from the cell, while the upper floor is formed of cement gratings upon which the garbage rests. The outside wall contains openings between the bottom and upper floors for the admission of air, which rises

through the upper floor into the garbage and also through four vertical air passages in the four corners of each cell, from which vertical passages or chimneys the air passes through openings to the under sides of horizontal fillets or baffles, three or four of which extend around the four sides of the cell. Into this cell the garbage is dumped through a trapdoor in the roof until the cell is nearly filled, when the door is closed and the garbage allowed to stand and ferment while other cells are being filled.

The gases from the fermentation pass through an opening into a small tower which connects with each unit of four cells and which contains horizontal trays on which is placed earth or substances adapted to fix the nitrogen and ammonia which constitute a large part of the gases, the liquified gases continually dripping down and finding their way into the cells to enrich the fertilizer.

The fermentation cycle usually requires from 35 to 45 days, when the material, which is now practically odorless and with comparatively little moisture, is removed through a door in one wall of the cell. This material resembles humus and is excellent for treating soils and contains considerable fertilizing property.

The capacity of one chamber being 25 cubic yards and the fermentation cycle requiring approximately forty days (including cleaning, etc., eight cycles per year are usually practicable), the number of cells necessary for any particular community can readily be calculated. As the amount of garbage to be treated increases, additional units can be added at will.

Thermometric and biological studies have disclosed a number of interesting features of the process. The temperature of the cell begins to rise on the third day after charging, the rise being more rapid nearest the bottom and sides, where air is introduced. Shortly thereafter it reaches 140 degrees to 150 degrees Fahrenheit by reason of the natural fermentation. The maximum temperature is reached on or about the tenth day after charging and remains practically constant for about twenty days, when it begins to fall and between the thirty-fifth and forty-fifth day the material has cooled sufficiently to be removed from the cell. Carcases of dead animals are reduced to skeletons entirely free from flesh in from twenty-five to thirty-five days, with at no time an odor of putrid flesh. Any material can be deposited in these cells, but of course it is uneconomical to use them for storing ashes and other inert material. On the other hand, it is hardly worth while to endeavor to remove tin cans and other materials ordinarily found in American garbage pails. If desired, these can be removed more conveniently when the resultant product is taken from the cell as a dry, comminuted mass. It is desirable however to use the cells only for the contents of garbage pails, the citizens being required to keep this matter separate from ashes and rubbish.

In designing the plant it is of course necessary to take into consideration the peak load rather than the average load. This load, however, usually comes in August and September, and as fermentation is most active during warm weather, this partially offsetting condition can be taken into account.

In order to prevent too great retarding action of cold in the winter climates of the northern part of this country, provision is made for surrounding the cells with an enclosure, from which will be drawn the air that serves to oxidize the fermenting garbage. This enclosure would also be used for temporary storage of the product removed from the cells which, because of its heat, would assist in keeping up the temperature during winter conditions.

One of the nuisances found in most garbage plants is that of flies. To prevent this, provision is made to receive the garbage carts in an enclosed area on top of the cells, which will be thoroughly screened in summer. As soon as the canvas cover is removed from a load, an insectide is sprayed over the garbage and the flies destroyed and the garbage at the same time deodorized. After having dumped its load into the cell, each garbage truck or wagon can be cleaned before leaving. This enclosure can also be used as a garage for storing collection carts during the night, the enclosure surrounding the cells being used for the same purpose if desired.

An Italian bacteriologist, Professor Guiseppi Gasperini, conducted experiments at Florence to determine the effect of Becarri fermentation on various types of micro-organisms. He found that at the end of the twenty-third day all life unfavorable to man and agriculture and all animal infesting parasites had been completely destroyed. The non-liquifying microbes of putrefaction decreased very rapidly, having practically disappeared by the tenth day, as had also the liquifying microbes. B. Coli. were found to decrease from about 375,000,000 on the first day to 100,000,000 on the thirteenth day. Anthrax sporoginies decreased from 225,000,000 to about 6,000,000 on the twenty-third day. On the other hand, certain microflora were almost eliminated during the first five days while the heat was rising, but after the forty-fifth day until the sixtieth day rose very rapidly. The part played by these species was not known but is being studied, we are informed, by Prof. Gasperini.

The general process, it is seen, is practically that which is carried on in a mulch pile which the farmer or market gardener frequently forms by the piling together of garbage, leaves and other vegetable matters and which he uses as a top dressing for vegetable gardens and the like. In the Becarri cell, however, conditions are maintained more favorable for the rapid action of bacteria, and especially for the rapid inaugurating of the fermentation, preventing of chilling during cold weather, retention and liquification of the nitrogenous gases and other features permitting of more scientific control of the function which nature itself originates in all masses of organic matter when allowed to stand undisturbed.

Operation of Gloversville Sewage Disposal Plant

Data for the year 1922 of a plant treating sewage with a high percentage of tannery wastes, using fine screens, Dortmund tanks and trickling filters.

By H. J. Hanmer *

The operation of the Gloversville, New York, sewage disposal plant may be of interest to many sanitary and city engineers because of the fact that between 35 and 40 per cent. of the sewage of the city is tannery wastes.

The following article, with its tables, will give a summary of the results of the operation of the plant for the year 1922, together with the itemized cost of the operation of the same:

Quantity and Flow—The total flow treated was 1,072.06 million gallons. The average flow passing through the treatment plant for the 12 months was 2.94 m. g. d.

Screen Chamber—The total screenings removed from the bar screens were 3,482 cubic feet, or 3.4 cubic feet per million gallons of sewage treated.

Grit—The deposits of sand and grit in the primary tank inlet troughs were removed 6 times during the year. The total amount was 1,115 cubic feet or 1.04 cubic feet per million gallons of sewage treated.

Fine Screens—As the sewage effluent leaves the primary tanks it passes through fine-mesh wire screens ranging in size from ½ inch down to ⅛ inch mesh. No record was kept of amount of deposit on these screens as they were cleaned by being removed and washed with a hose, this being a continuous operation from 7 a. m. until 8 p. m. from Monday until Friday, inclusive, and on Saturdays and Sundays from 8 a. m. until 5 p. m.

Primary Tanks—The primary tanks are two in number, of the Dortmund type, about 48 feet deep and 35 feet in diameter, with hopper-shaped bottoms. Sludge was drawn from the tanks about four days each week, the average time of drawing being about 1½ hours daily on those days on which drawing occurred.

During the twelve months, 6,365,450 gallons, or about 5,935 gallons of sludge per million gallons of sewage treated, was pumped to the sludge drying beds.

Averages of monthly averages of the analyses of the primary tank sludge indicate a solid content of 4.44 per cent. and a specific gravity of 1.015.

Using these averages, the amount of dry solids removed in the form of primary tank sludge was about 1,930 pounds per million gallons of sewage treated.

Distributor Manholes—There are three of these manholes on the main distributor, one at each secondary distributor leading to each acre of trickling filters. A large amount of grease collects in these manholes, and during the year about 512 cubic feet of grease and sludge were removed from them.

Trickling Filters—The filters, which have an area of 3 acres, have been operated so that each of the three units was rested in alternation for two weeks at a time. Of the 620 nozzles in operation at one time, an average of about 50 per day have been cleaned. It is necessary to clean the nozzles once every year, due to the incrustation on the underside of the lobes of the spindles.

Secondary Tanks—The secondary tanks are two in number, of the Dortmund type, about 29 feet deep and 35 feet in diameter and with hopper-shaped bottoms. Sludge was drawn from these tanks from once to five times per month, depending upon the unloading of the trickling filters.

During the year 2,194,600 gallons of sludge, or about 2,050 gallons per million gallons of sewage treated, was drawn and pumped on to the sludge beds.

Averages of monthly averages of analyses of the sludge gave a solid contents as 6.02 per cent. and a specific gravity of 1.016. With these averages the amount of dry solids removed in the form of secondary tank sludge was 1,030 pounds per million gallons of sewage treated.

Sludge Beds—The area of the four sludge drying beds is about 2.65 acres. All four beds were

Summary of Results of Analyses of Crude Sewage, Jan.-Dec., 1922.

Parts per Million. (Straight average of bi-weekly composite samples.)

Total Solids	Organic Solids	Suspended Solids	
		Total	Organic
1662	512	416	280

Organic Nitrogen	Albuminoid Nitrogen	Ammonia Nitrogen	Oxygen Consumed
38.09	13.73	16.57	272.7

HAULING DRIED SLUDGE FROM DRYING BED.

*City Engineer of Gloversville, N. Y.

EFFICIENCY OF DISPOSAL PLANT AS SHOWN BY ANALYSES

Average results for the year 1922.

Primary Tanks

	Influent	Effluent	Removed	% Removed
Settling solids, c.c. per liter in 2 hrs., quiescent sedimentation	10.00	1.49	8.51	85.1
Total suspended solids, p.p.m.	416	134	282	68
Organic suspended solids	280	97	183	65
Total organic nitrogen	38.09	29.33	8.76	23
Suspended organic nitrogen	16.02	7.90	8.12	51
Total albuminoid nitrogen	13.73	9.70	4.03	29
Suspended albuminoid nitrogen	6.82	2.70	4.12	60
Total oxygen consumed	272.7	151.8	120.9	44
Suspended oxygen consumed	62.3	20.9	41.4	67

Trickling Filter

	Influent	Effluent	Removed	% Removed
Total suspended solids	134	139	Increase	
Organic suspended solids	97	113	Increase	
Total organic nitrogen	29.33	19.99	9.34	32
Suspended organic nitrogen	7.90	7.04	0.86	11
Total albuminoid nitrogen	9.70	7.52	2.18	23
Suspended albuminoid nitrogen	2.70	3.20	Increase	
Free ammonia nitrogen	14.63	12.45	2.18	15
Total oxygen consumed	151.8	124.3	27.5	18
Suspended oxygen consumed	20.9	20.3	0.6	2.9

	Nitrites	Nitrates
Nitrogen in effluent, p.p.m.	0.98	1.38

Secondary Tanks

	Influent	Effluent	Removed	% Removed
Total suspended solids	139	64	75	54
Organic suspended solids	113	51	62	55
Solids settling in 2 hours, c.c. per litre	2.03	0.32	1.71	86
Total organic nitrogen	19.99	17.53	2.46	13
Suspended organic nitrogen	7.04	3.75	3.29	47
Total albuminoid nitrogen	7.52	5.02	2.50	33
Suspended albuminoid nitrogen	3.20	1.56	1.54	48
Ammonia nitrogen, p.p.m.	12.45	12.26	0.19	2.0
Total oxygen consumed	124.3	113.5	10.8	9
Suspended oxygen consumed	20.3	13.6	6.7	34

	Influent	Effluent	p.p.m. Difference
Nitrite nitrogen	0.98	1.38	—0.40
Nitrate nitrogen	1.38	1.19	—0.19

Efficiency of Entire Treatment Plant (not including sand beds) as shown by analyses.

	Influent	Effluent	Removed	% Removed
Total suspended solids	416	64	352	85
Volatile suspended solids	280	51	229	82
Total organic nitrogen	38.09	17.53	20.56	54
Suspended organic nitrogen	16.02	3.75	12.27	76
Total albuminoid nitrogen	13.73	5.02	8.71	64
Suspended albuminoid nitrogen	6.82	1.56	5.26	76
Ammonia nitrogen	16.57	12.26	4.31	26
Total oxygen consumed	272.7	113.5	159.2	58
Suspended oxygen consumed	62.3	13.6	48.7	78

in operation during the year and received approximately 1,130,357 cubic feet or 8,364,640 gallons of wet sludge, both primary and secondary. About 5,555 cubic yards of dry sludge was hauled from the beds by the city team and 122 cubic yards by the farmers, making the total removed 5,677 cubic yards. The depth of wet sludge, if applied proportionately to the 2.65 acres of beds, would have been 9 2/5 feet.

Gloversville's sewage disposal plant was operated under the immediate supervision of H. J. Hammer, city engineer, with Saul Robinson, chemist, in charge.

ITEMIZED COST OF OPERATION

Foreman	$1,560.00
Chemist	1,617.00
Office building and tool repair	23.14
Miscellaneous labor	167.60
Telephone	57.37
Electric power for pump	270.98
Gas and electricity	123.18
Team account	752.37
Materials and supplies	347.99
Sand for sludge beds	72.43
Removing and replacing cover to trickling filters	230.34
Operation and maintenance of screens	2,219.26
Operation and maintenance of centrifugal pump	1,300.68
Operation and maintenance of trickling filters	571.61
Operation and maintenance of sludge beds	2,706.10
Operation and maintenance of sand filters	198.41
Operation and maintenance of land	192.56
Cutting grass and brush	47.17
Maintenance of roads and lawns	201.55
Cleaning troughs in tanks	48.45
Total	$12,708.19

Winter Destruction of Boston Streets

In a communication to the Commissioner of Public Works, Mayor Curley of Boston stated that last winter was unquestionably the most severe that the city has known in its history, with a total snowfall of 70 inches and with ice coating the streets for a period of nearly ten weeks. He recommended that spring cleaning and repairing of streets be begun before the end of March instead of waiting until April or May as is customary.

More than two-thirds of the street mileage of Boston, or approximately 420 miles, is of macadam or Telford construction and is always in need of repair at the close of even a mild winter, but a great many of them are now, the Mayor states, in actual need of complete reconstruction because of the severity of the past winter.

Hard Winter on Roads

Reports are received from all sections in the eastern states of unusual destruction of roads by heaving. For instance, State Highway Commissioner Greene of New York State reported in April that he would need about $3,000,000 to put in shape the roads that had boiled up in that state this spring, the damage being much greater than ever before. It was attributed by him to the unusually large amount of heavy trucking done during the winter. He declared in some cases the roads have boiled as high as 5 feet for areas of from 10 to 70 square feet. It seems very probable that one of the principal causes contributing to the excessive heaving of roads during the past winter was the unusual extent to which the departments have kept the snow cleared from the roads, the snow in former years having served to protect the road and its subgrade from the low temperature.

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Co-operation for Public Officials

A feature of the discussions at the convention of the American Water Works Association last month that impressed the writer was the frequent and general advocacy of co-operation between public officials and private citizens in securing the observation of laws and regulations rather than resort to threats of penalties and punishment.

In considering the best methods of protecting water-sheds, for example, the several speakers on the subject were almost unanimous in their belief that continuous protection from pollution and freedom from objectionable uses were almost impossible of attainment by patroling and efforts to enforce regulations by arrests and legal actions; but that appeals to the owners of property, and education of them and of the citizens at large on the dangers to water consumers of the practices objected to, would result in 75 to 90 per cent. of the citizens acting as voluntary inspectors to restrain the 10 to 25 per cent. of refractory ones.

Again, engineers and health officials who are searching for methods of preventing the pollution of streams by trade wastes reported finding manufacturers not only willing to adopt proved methods of treating the waste waters from their plants, but even offering to co-operate in investigations aimed at the development of such methods.

Managers of privately owned public utilities also told of securing the good-will of the citizens they serve by showing their own good-will toward the municipality. An impersonal corporation, bent only on making money for its stockholders, is naturally an object of suspicion and dislike to the average citizen; but let the personal representative of the corporation take a public-spirited interest in municipal affairs as a fellow citizen with the other business men, and display the same intent to please its customers, and this animosity will disappear.

As is frequently stated, the public generally wishes to be reasonable and fair, and if public officials will themselves be so, will take the trouble to prove the reasonableness of the regulations they promulgate (and admit it if they find it unprovable), and will ask the co-operation of the citizens in carrying them out, many of their present difficulties and dissentions will disappear.

Unfair to the Contractors

More than two months ago a southern city received bids for an 80-ton garbage incinerator. The contract was awarded and the contractor gave a bond, but for six weeks following the award the city council continued unable to agree upon a location for the incinerator and the commissioner of health finally recommended that the company be relieved of the contract and its bond returned. For the time being, however, action was deferred in the hope that a location might shortly be settled upon.

Most contracts contain provisions that the contractor must begin work within a certain number of days after being awarded the contract and notified to begin, and that he will be subjected to penalty for delay. Few if any, however, contain any clauses providing for awarding satisfaction to the contractor if he himself shall be delayed. Here we have the construction held up for two or three months and possibly more after the awarding of the contract for no fault of the contractor but for one which lies entirely with the city. Meantime the contractor is carrying a bond, presumably is holding men and material in readiness to start the work, and probably is liable to loss through increase in cost of materials and labor. He undoubtedly will have some recourse to law should the city attempt to cancel the contract, but can he obtain reimbursement for these losses if the contract is carried out?

This is not the only instance, by any means, of

long delays in beginning the work for which the party of the first part is entirely responsible. In the majority of cases the contractor is not only wasting time which means money to him, but is suffering an actual loss through delay. It seems to us that an equitable form of contract would contain proper provision for protecting the contractor, as well as the city or other party of the first part, against loss from delays caused by the other party to the contract.

The Escanaba Manager Plan

Escanaba, Mich., is the first city to establish a city manager corps, according to the "National Municipal Review," its new charter providing for a group of managers. The new government is starting with a manager and two assistant managers.

Says Robert T. Crane in the Review: "A number of cities have provided for an assistant manager in the sense of a deputy or vice-manager. The Escanaba plan is different. By the charter, the manager is head of all departments until otherwise provided, as is the case in many municipalities. But when it is necessary to relieve the manager of some portion of his task, other cities have set up one or more department heads in addition to the manager. These new department heads in such cities mark a notable change from the prior situation; the headships of the department are henceforth divorced from the manager's office. Escanaba, on the contrary, keeps the headship of every department where it started—in the manager's office. It does so by assigning the direct management of a department, when necessary to relieve the manager, to an assistant manager, and as many assistant managers may be employed as the council shall determine."

Mr. Crane believes that this plan will tend to cause the selection for city manager of men with executive ability as their great qualification rather than engineering ability. Also, that it will help to provide trained managers in that these may be selected from the most promising of the assistant managers.

Baltimore Division of Permits

The Division of Inspection, Permits and Footways of Baltimore in 1922 earned $17,859 over and above the salaries of all per-diem inspectors, clerks and assistants on monthly salaries, and the chief inspector. "This estimate includes amounts which accrue from billing public service corporations, individuals and contractors for the use of city inspectors on permits which we issue and includes cash deposits made with the city comptroller on the permits issued for the storage of building material in the public streets and other inspections of a miscellaneous character." The charges for permits during the year totalled $35,044.

Among the items covered by these permits was the construction of 13,795 feet of conduit by the Chesapeake & Potomac Telephone Company, which called for approximately 2,000 square yards of repaving by the Street Repair Division. The city is now collecting from this company in duct rental the sum of $63,589. Six thousand nine hundred different locations were inspected for work done by the United Railways and Electric Company in renewing and repairing tracks and structures. This company repaved within its track area 18,828 square yards of sheet asphalt pavement and approximately 25,000 square yards of other improved pavements, all of which was inspected by this division. For the gas company, inspection was given on 100,000 feet of gas mains and 360,000 feet of service pipes, as well as work repairing leaks, etc. In addition to inspecting 12,000 openings made in the public streets by this company, the division made 2,000 preliminary inspections before issuing permits.

The various pole and electric operating companies performed work under 5,280 permits in 12,000 different locations.

Rudolph Hering

Rudolph Hering died in New York City on May 30th.

Dr. Hering was 76 years old and for 35 years had been the outstanding figure in sanitary engineering in the United States. In 1886 he reported on the water supply of Philadelphia. He was largely responsible for the adoption of the plans for the construction of the Chicago drainage canal for removing the sewage of that city; he was a member of the commission which in 1904 recommended that New York obtain its water from the Catskill Mountains, and had been employed as consulting engineer at some time by most of the large cities of the country on either sewerage or water works problems. He was largely responsible for the prominence of the Imhoff tank in sewage treatment in the United States.

He was for several years a member of the firm of Hering and Fuller and later of the firm of Hering and Gregory. His last work of prominence was the writing of a book on Collection and Disposal of Municipal Refuse, in collaboration with Samuel A. Greeley. He retired from practice two or three years ago and returned from an extended European trip last October.

He was a very prominent member of the American Public Health Association, American Society of Civil Engineers, American Society for Municipal Improvements, and other technical societies. For a generation he was the acknowledged dean of sanitary engineering in this country. In spite of his years he was up to the last exceedingly active both physically and mentally and maintained a deep interest in all matters relating to sewerage, water supply and refuse disposal and was a frequent attendant at the conventions of all societies interested in those subjects. The convention of the American Water Works Association in Detroit a week before his death was, we believe, the first he had missed in some years. At this convention the directors had recommended to the society that he be elected to honorary membership, which recommendation was unanimously adopted by the convention.

American Waterworks Association Convention

Papers, discussions and other features of interest at the forty-third and most successful convention of this society, held in Detroit, May 21st to 25th.

The forty-third annual convention of the American Waterworks Association at Detroit was attended by a larger number of members, it is believed, than any previous convention of this society. On the morning of Friday the secretary reported 528 active members as having registered and about 200 associate members, while the number of guests was nearly 400, although only about 200 of them were from out of town. There was no question, after the first day, that the required number of railroad certificates would be presented for securing the half-fare return rate, and, in fact, nearly 600 of these certificates were received by the secretary.

The meetings were unusually well attended, not less than 100 to 150 being present at every session and a considerably larger number at some of them. The exhibits were similar in character to those seen at most of the conventions of this society in recent years and even greater in number. They occupied two large rooms adjacent to the assembly hall.

During the last two days the members met in two different halls as two sections, the superintendents and the chemists and bacteriologists.

Practically no discussion was given to the papers read on Tuesday and on Wednesday, but with the papers on Thursday morning discussion began which continued throughout the remainder of the convention, it being necessary in some cases to cut short the discussion of a paper in order to complete the program. Thursday's papers comprised reports of the various committees of the Standardization Council, while Friday's sessions consisted of sectional meetings by the superintendents in one room and the chemists and bacteriologists in another.

The convention devoted an unusually large proportion of its time to meetings and discussions and only one half day to any entertainment feature. The superintendents even began on Monday afternoon a discussion of the topics and questions on the superintendents' program, while other members listened to and discussed a description of the methods of accounts and records kept by the Detroit Waterworks. Business sessions were held three times on Tuesday and Thursday and twice on Wednesday and Friday, each session being about 2½ hours long. This was probably as long, considering the number of meetings, as could be profitably attended by the delegates without overtiring them, although it seems to us unfortunate that more serious effort was not made to begin the sessions promptly at the time appointed, each of them being about 30 minutes late in starting.

The next convention is to be held at Memphis. The officers for the year 1923-24 will be: George W. Fuller, president; Frank C. Jordan, vice-president; William W. Brush, treasurer, with presumably no changes in the secretary and editor.

The Executive Committee proposed and the convention elected as honorary members: George H. Benzenberg, Desmond Fitzgerald, Rudolph Hering, William Mulholland, Sir Alexander Houston and J. H. Purdy.

The reports of the finances by the secretary, the treasurer and the finance committee showed the society to be in a healthy condition in this respect. The expenditures had been kept within the budget and were several hundred dollars less than the income. The finance committee recommended a budget for the coming year of $23,000, which allowed some increases in the expenses of the Secretary's office, for publishing proceedings, and a few other items.

The Nicholas S. Hill, Jr., Cup for the section showing the largest percentage of growth was awarded to the North Carolina section which showed a 66-2/3 per cent. increase.

NARRATIVE OF THE CONVENTION

By Monday night about 300 active members and 140 associate members had registered, and, although the formal sessions did not begin until Tuesday, a very interesting and well-attended, informal meeting was held at the office of the Detroit Waterworks, where was described by certain officials of the plant the method of keeping accounts and making records and reports, and the subject was discussed by those present. At the same time a meeting was held at the Hotel Statler by the superintendents, at which the first ten or twelve subjects on the list of questions that had been prepared for discussion were taken up.

TUESDAY

Tuesday morning's session began with the president's annual address. The publication committee and finance committee asked to have the presentation of their reports postponed to a later session.

The standardization council referred to its report which had already been published in the May issue of the Journal of the society. The council urged that the reports of its committees be discussed, both at the meeting and later by correspondence if members were not prepared for discussion at the convention, these discussions to be published in the Journal later. Mr. Fuller,

chairman of the council, stated that it was its policy to change one or two members of each committee each year so as to insure a continuity of policy.

The report of the committee on standard form of contract also had already been published in the Journal and the chairman, J. Waldo Smith, referred to this published report.

Following this, Mortimer P. Lane, of the Department of Commerce, representing Secretary Hoover, read a paper which consisted of a survey of the present business situation. He asked that the members of the society make general use of the regular publications of the department giving the latest information on current business conditions and, by following the recommendations contained therein, aid in stabilizing the business of the country.

Sheriff Walters of Wayne County gave an address of welcome in place of the Mayor, who was absent from the city on business, in which he was seconded by Col. Francis L. Sward, the water commissioner.

A paper on "The Use of Constant and Variable Speed Motors for Driving Water and Sewage Pumps," illustrated with lantern slides, was read by F. L. Adams. This was followed by a paper by Charles B. Burdick of Alvord, Burdick & Howson, describing a number of pumping stations that had been built by them as engineers and explaining some of the general principles employed by them in designing. Special attention was paid to the new 21st Street pumping station at Des Moines, while stations at Orlando, Gary and other cities were referred to and photographs of them shown upon the screen. In general, the important features were considered to be the use of incombustible material for the roofs, provision in the design for expansion or duplication of machinery necessary for a number of years to come, and attention to lighting, ventilation and general neatness of appearance in the station and grounds and architectural treatment of the building.

"Determining the Proper Equipment for Pumping Stations" was the title of a paper by Arthur L. Mullergren, in which he dealt with the pumps, boilers and auxiliary equipment. The author's opinion that turbine-driven centrifugals had reached the point of development where they were the most economical pumping equipment was questioned by J. N. Chester, who did not believe that such a pump was economical for capacities below 15,000,000 gallons per day with coal at $4 a ton or more, but he believed that for such sizes the horizontal cross compound was still a more economical pump.

In the afternoon C. C. Cocert read a paper, illustrated with lantern slides, entitled, "Records of Stream Flow, Their Use and Best Methods of Obtaining Them for Municipal and Industrial Purposes." In this he described the methods employed by the U. S. Government engineers, telling how to select ganging stations, the different methods of ganging suitable for various widths and depths of stream, different types of gauges employed, etc. Scotland G. Highland called attention to the importance of "The Collection and Daily Publication of Meteorological Data by the Water Department." Dabney H. Maury described some recent large waterworks projects with which he had been connected, including those at Denver, Norfolk and Tulsa, also the construction of waterworks for the Army cantonments. At the conclusion of this paper Mr. Maury referred to the suits brought against a number of the men connected with the construction of the cantonments and expressed with feeling the injustice being done them, and following this paper the society unanimously adopted a motion that the Attorney General be requested to bring these cases to immediate trial; this being in line with similar motions which had been adopted by a number of other organizations of engineers and contractors during the past few months.

The last paper of the afternoon was a description by James W. Armstrong, with lantern slides, of the design of the proposed water filtration plant at Baltimore. This plant contains several unusual features, one of the most important being the entire omission of strainers in the filters, the floors being made simply in the form of planes draining to an outlet, on which are placed directly gravel and sand in sizes graded from coarse to fine. One of the filters of standard construction in the existing Baltimore plant had been altered a year or more ago by removing the strainer system and placing the filtering material directly upon the floor and had been operated in this way in the general service of the station for a year without giving any trouble whatever or showing any indications of a penetration of the sand into the supporting gravel. There were also a number of other features in which the proposed filter plant will vary from the standard practice.

The evening session was devoted to two papers; one descriptive of the waterworks of Detroit, by George H. Fenkell, and the other a description of the Detroit filtration plant, approaching completion, by Theodore A. Leisen, both abundantly illustrated with lantern slides. These gave the delegates a good idea of the waterworks of the city which they were to visit the following afternoon. The papers had been printed in advance and were distributed to those present, and the authors confined themselves largely to a running comment on the pictures shown upon the screen.

WEDNESDAY'S SESSIONS

The morning session opened with the paper of James R. McClintock describing, "Recent Water Developments at Memphis." Mr. McClintock's firm had reported upon a reconstruction of the Memphis waterworks in order to secure additional water to meet the growing demands and also one that would give less trouble from iron and other impurities. The use of the river water was not considered the best solution, but it was finally decided to drill new wells within convenient drawing distance of the pumping station and treat the water for the removal of iron and of carbon dioxide by aeration and rapid filtration. Caleb M. Saville then described "The Hartford Method of Paying for Waterworks Construction," referring especially to extensions of the distribution system. This paper was not discussed at this meeting, but on the following day, at the meeting of the waterworks superintendents, there was considerable discussion and comparison of methods employed in different cities. The final paper of this session was one entitled, "Municipal Team Work," by Frank C. Jordan. Mr. Jordan gave the word "neighborliness" as embodying the spirit that he believed should actuate the superintendents of waterworks in their dealings with consumers and other city departments.

Following the papers, the special order of business of selecting the place for holding the 1924 convention was taken up. Among the cities which the committee reported as having sent invitations were: Atlanta, Chicago, Des Moines, Evansville, Los Angeles, Memphis, Milwaukee and Montreal. At the first ballot Memphis and Montreal were almost tied, with the others receiving very few votes, and a second ballot between these two resulted in the choice of Memphis.

In the afternoon the guests left by buses, furnished by the Waterworks Manufacturers Association, for the Detroit filter plant, where a luncheon was served, followed by a trip by boat through Lake St. Clair.

The evening session consisted of three papers by members of the Manufacturers' Association, in which James H. Caldwell described the manufacture of a 28-inch gate valve by the Ludlow Valve Manufacturing Company; John D. Capron showed in moving pictures the manufacture of cast-iron pipe, first by the old method and then by the centrifugal method; and D. R. Johnson, by moving pictures, described the method of installing a brass well screen and then recovering such a screen from a well. At 9:30 the members adjourned, most of them to a smoker given by the Waterworks Manufacturers Association.

The nominating committee reported the following choice of the committee for elective offices next year: President, Frank C. Jordan; vice-president, Harry F. Huy and Chas. B. Burdick; treasurer, W. W. Brush; trustees, District 3, E. M. Hoopes; District 6, F. M. Randlett and J. A. Jensen.

THURSDAY'S SESSIONS

Thursday was devoted to reports of the standardization council committees; being preceded, however, by the postponed paper of Beekman C. Little entitled, "Iodine Treatment of a Water Supply as a Preventative of Goitre," in which Mr. Little advocated administering to consumers at intervals of about six months minute doses of iodine.

The reports of the Standardization Council committees had been printed and some had been already published in the *Journal*. For this reason they were presented in more or less brief abstracts.

Water Shed Protection—The first of these was the report of the committee on Watershed Protection, presented by H. E. Moses. The committee did not advocate the ownership of watersheds, believing that such ownership would not protect against trespass and would probably give over-confidence on the part of water users if not of the water department, and believed that even the purchase of marginal strips in inhabited watersheds is of doubtful value in reducing the pollution. Several members discussed this report.

Allen Hazen advocated ownership to prevent or control the manner of development of the shed if for no other reason, even though it were not considered practicable or desirable to remove the present occupants or to prevent further development, and in this he was endorsed by Mr. Little. Mr. Chester raised the question of the legal status of an investment in an extensive watershed when the question of rate-making came before the public service commissions.

H. F. Ferguson, chief engineer of the Illinois State Department of Health, referred to the tendency of cottagers to build along the shores of lakes and large reservoirs unless prevented by control of the watershed. The State Board considers that all surface supplies require treatment and that it is impracticable to entirely prevent pollution. It considers that bathing is largely a matter of sentiment and for this reason confines it to some distance from the waterworks intake, establishing zones, each zone having its own restrictions which become less stringent as the distance from the waterworks intake increases. Mr. Saville believed in stringent rules even though they were not enforced, believing that they would have a moral effect, and that there would be less fishing, bathing, etc., if it was known that doing so was illegal.

George R. Taylor believed marginal ownership of reservoirs to be very desirable in order to prevent cottages along the shore and fishing. He had found the best policy to be a co-operation with the residents on the watershed in the prevention of pollution of the reservoir, this consisting in some cases of assuming the disposal of sludge from septic tanks and privies and the removal of other wastes in such way as to prevent pollution of the water. In his opinion, the milk inspectors working in the district should co-operate with the waterworks company or department. His company also took an interest in the health of the residents on the watershed and endeavored to co-operate with them in maintaining sanitary conditions. One advantage of co-operation was that it is generally almost impossible to obtain convictions if cases of violation of laws for protection of watersheds are taken before a jury.

Herman Rosentreter, of Newark, stated that the ownership of the watershed from which that city derived its supply had resulted in a very considerable reduction in the bacterial content of the water. Another member stated that in New York regulations concerning watersheds were enforced jointly by the State Board of Health, the local Board of Health and the water board or company. If, following the complaint of the last named or for other reasons, the state board called upon the local board to enforce the regulations and it refused to do so, the state board can mandamus the local board.

Industrial Wastes Pollution—The report of the Committee on Industrial Wastes in Relation to Water Supply was presented by Almon L. Fales in abstract and discussed at some length. In this, even more than in the previous discussion, co-operation was recommended by the members. Mr. Bartow had found co-operation with manufacturers successful in restricting beet sugar pollution and that from other sources. Beet sugar pollution exists for only 70 to 120 days per year and it is therefore impracticable to construct elaborate plants for treating this waste. In general, he believed that the most promising solution of this problem lay in the conservation of wastes.

Mr. Chester referred to the enormous amount of drainage from the coal mines that reached the streams of Pennsylvania. The right of the mines to discharge these acid waters into the streams is the subject of a suit which has already been through one court and will probably be carried to the supreme court for decision. Two very stringent bills were before the Pennsylvania Legislature (which was still in session during the convention) and Mr. Moses explained in detail the present status of these bills, only one of which had any prospect whatever of passing. Mr. Bohman referred to the tastes in the Milwaukee water which were at first attributed to chlorine but which were later found to be due to wastes from the manufacture of tar products. Mr. Saville stated that the Connecticut Legislature had passed a bill looking to the abolishing of wastes by preventing the installation of new plants contributing such wastes, then by requiring the elimination of those for which there are known remedies, with the hope of discovering remedies for the others and applying them later on.

Richard Messer, state engineer of the Virginia Health Department, through a representative, reported that legislation in that state has not yet become necessary but that the manufacturers show a readiness to co-operate with the state department in minimizing stream pollution. L. L. Jenne, of the Philadelphia Bureau of Water, stated that nature had co-operated with the city in purifying the water in the Schuykill river in that, after receiving the acid mine wastes, it flowed through a limestone country where the lime neutralized the acids. By co-operation with the gas plants along the river the city had secured a very considerable reduction in the tarry discharges. No method, however, had been found for preventing the tastes due to tar compound wastes. Very great improvement in taste could be obtained by the slow sand type of filter, whereas the rapid sand produced apparently no effect.

McKeesport's experience with the treatment of acid waters was reported by E. C. Trax. Robert Spurr Weston considered the problem was an economic one and that the economics of the problem should be given first consideration. He stated that in his state also manufacturers were eager to co-operate, one having even voluntarily asked the state board of health to advise and aid it in preventing stream pollution.

C. M. Baker stated that in Wisconsin the problem was mostly one of stream pollution rather than of water supply. The manufacturers were reasonable, but industrial pollution cannot be entirely prevented. The state suggests or offers co-operation rather than endeavoring to enforce stringent regulations. Mr. Baker recommended that a committee of waterworks men, manufacturers, conservationists and others co-operate in efforts to find solutions to the problem. Mr. Ferguson stated that the Bureau of Mines is beginning an investigation to determine whether it is possible to cure the nuisance due to coke oven wastes, this action being the result of a recent meeting of several federal departments interested in the subject.

At this point Dow R. Gwinn introduced a motion that the third Tuesday in May be celebrated as "Waterworks Day," the citizens being invited to visit the waterworks plants. This was adopted after the mover had accepted the amendment that the date be set by the executive committee.

Cast Iron Pipe—The report of the committee on Standard Specifications for Cast Iron Pipe was presented by Frank A. Barbour. The committee had paid special attention to the test bar and had studied a special type, and recommended that the deflection increase with the breaking load. It seemed to have been demonstrated that some at least of the manufacturers of cast iron pipe had been turning out a poorer product during the past few years than formerly and, in fact, that the prod-

uct of less than 75 per cent. of the manufacturers would meet the proposed specifications. The committee also is investigating the matter of testing a ring cut from the end of the pipe rather than a bar, the ring more truly representing the iron as it is actually furnished consumer.

Thomas H. Wiggin thought it probable that the deterioration was due to the poorer coke furnished to the pipe manufacturers by the coke companies and to the overworking of the cupolas during recent years. He did not consider the bar a good test of cast iron, since molten iron cast into a bar does not crystallize in the same way that it does in a pipe or other large casting and the testing of rings seemed to him to be preferable. Messrs. Hawley and Saville believed that foundry practice is as important in the manufacture of pipe as the chemical or physical characteristics of the metal used.

Meter Schedule Slides—The report of the committee on Steps Towards Standardizing Stated Quantities for Slides in Meter Schedules was presented by Isaac Walker in the absence of the chairman, Allen Hazen. The committee reported that it presented a report based upon the New England Waterworks schedule adopted about six years ago. Cities using this schedule had all been questioned and reported themselves pleased with it, and individual members of the New England Waterworks Committee had no important changes to recommend. This committee had only one change to recommend, and that was the addition of a fourth special rate for large industries. Reference was made to the serious objection raised in many states to the service charge and the term employed by Daytona, Florida, "annual maintenance charge" was suggested as probably being less objectionable to some of these non-technical critics. J. N. Chester approved of the schedule but believed that there would be some cases when only two sets would be desirable and others where more than four should be employed. He called attention to the fact that the state of Ohio forbids service charges in any form or name and that a similar law almost passed the present Pennsylvania Legislature.

The two committees considering "Essential Data for Water Records and Reports," Committee A for municipal plants and Committee B for privately-owned plants, had already printed their reports and these were accepted as progress reports, but certain inconsistencies between them were pointed out and the committees were instructed to get together during the coming year on the principles involved.

J. H. Gregory introduced a motion that the City Council of San Francisco be requested to rescind its action in naming the Hetch Hetchy dam the "O'Shaughnessy Dam," in that that name had already been given to a dam at Columbus, Ohio, in honor of Jerry O'Shaughnessy and that having two "O'Shaughnessy" dams would be a subject of much confusion. After some discussion the convention voted in opposition to the motion.

(To be continued)

Flushing Snow in Springfield

The chief engineer of the Water Department of Springfield, Massachusetts, Elbert E. Lockridge, in his report for 1922 stated that the use of water for flushing snow from the streets constitutes the greatest menace to efficient water service and at times entirely deprives the city of fire protection, presumably by using practically the capacity of the mains. He stated in this report that the practice was still being continued, but with the opening of a new bridge, the possibility of dumping some of the snow into the river through openings provided would, he hoped, reduce the amount of flushing and that still other means would be found of disposing of more of the snow in some manner other than wasting the water and reducing the pressure to the consumers and incurring considerable risk in case of fire.

In connection with sprinkling streets, Springfield has taken precautions against damaging fire hydrants, which might well be copied by other cities. There are in the city 85 crane hydrants or standpipes used for filling sprinkling carts, 51 owned by the waterworks department and 34 by the street department. In addition, the street department has 29 track hydrants for car sprinklers and 57 special hydrants installed for street washing. This is a total of 171 special hydrants installed for the sprinkling and washing of streets. With this generous provision there should be no excuse for the use of the regular fire hydrants for any purpose other than fire protection, and presumably there is no damage done to the hydrants by such use, as so commonly occurs in other cities.

Oiling Pennsylvania Roads

The State Highway Department of Pennsylvania employs a regular schedule, decided upon in advance, for oiling roads and publishes this schedule for the information of the traveling public. It endeavored to cover as many of the principal highways as early in the spring as possible, 120 separate road sections having been given surface treatment in one week of May. Only one side of the road was oiled at a time.

The maintenance division of the State Highway Department was discontinued May 15th and the maintenance work is now being carried on through four divisional headquarters, the employees formerly connected with the maintenance division being divided among these four divisions. The engineers in charge of the new divisions are: J. S. Ritchey, for the Northeast Division; Samuel P. Longstreet, for the Southeast Division; Thomas C. Frame for the Northwest Division and S. W. Jackson for the Southwest Division. William A. VanDuzen, formerly assistant maintenance engineer, will have charge of the direction of automotive transport and will direct the highway transport survey.

Paying for Repaving

Percentage of cost of original pavement and of repaving assessed against abutting property by several hundred cities.

In the issue of February of this year we published several tables of paving data and referred to a table on "Payment for Repavement," which was omitted from that issue for lack of room and is given on the three following pages. This information was furnished by the city engineers or other officials of the cities in question. The reason for the question answered in the third column is that some cities do not assess "repaving" against abutting property, but do not consider macadam or a less durable surface as "paving" and therefore assess when paving replaces such a surface.

PAYMENT FOR REPAVEMENT

City	Percentage abutting property pays on: Original pavement	Re-paving	Are sand-clay, gravel or macadam classed as pavement?
Alabama:			
Birmingham	100	100	Yes
Arkansas:			
Blytheville	100	None	No
Searcy	100	100	Yes
California:			
El Centro	100	100	No
Oakland	100	100	Macadam
Santa Ana	100	None	No
Santa Barbara	80-100	90-100	....
Santa Monica	100	None	No
Santa Rosa	100	100	Yes
So. Pasadena	100	100	Macadam
Upland	100	50	Macadam
Vallejo	100	None	No
Visalia	100	None done	....
Whittier	100	100	No
Colorado:			
Denver	100I	None	No
Fort Collins	all but 50% of intersections	Same	Yes
Longmont	100	No rule	No
Pueblo	100	None	....
Connecticut:			
Ansonia	None	None	....
Bridgeport	None	None	....
Bristol	33⅓	None	No
Greenwich	50	None	No
Hartford	50	None	No
New Britain	$1.50 per front foot	....	No
New Haven	(m)	....	No
New London	None	None	No
Putnam	None	None	....
Wallingford	None	None	No
Willimantic	None	None	....
Delaware:			
Wilmington	66⅔	....	No
District of Columbia			
Washington	50p	50p	Macadam
Florida:			
Key West	25	25	No
Tallahassee	33⅓	None	No
Georgia:			
Americus	100	None	No
La Grange	66⅔	66⅔	....
Macon	66⅔	66⅔	No
Idaho:			
Boise	100I	100	No
Pocatello	100	100	No
Twin Falls City	100	....	No
Illinois:			
Benton	100	....	....
Canton	75	75	No
Carterville	100	....	Yes
Centralia	100	100	None used
Champaign	100	100	....
Chicago	100	100	No
Chicago Heights	100	100	No
Clinton	90	None	....
Collinsville	100	None done	Yes
Danville	85-90	50-90	No
Decatur	100	100	No
Dekalb	80	90	No
Duquoin	100	....	No
East Moline	100	100	No
East St. Louis	100	100	No
Edwardsville	95	90	....
Galva	100	....	....
Joliet	95	95	No
La Grange	100	100	Yes
Macomb	None	12-20	....
Mattoon	90-95	90-95	None used
Moline	....	75	No
Monmouth	100	100	No
Naperville	85-90	....	....
Normal	90	90	No
Oak Park	100	100	Macadam
Ottawa	95	95	No
Quincy	75	75	No
Riverside	100	100	....
Robinson	100	None yet	No
Rockford	70-85	None	....
Waukegan	Nearly all	Nearly all	No
Winnetka	100I	80	....
Indiana:			
Anderson	100	100	Yes
Attica	100	....	Yes
Boonville	100	....	No
Elwood	100	100	Yes
Fort Wayne	83-90	83-90	No
Frankfort	100I	100-I	No
Gary	100I	100-I	Yes
Huntington	....	....	Yes
Jasonville	100	....	Yes
La Porte	100I	100-I	....
Logansport	100I	....	Yes
Indiana (Continued)			
Martinsville	100	None	No
Peru	100I	100-I	No
Seymour	100	100	Yes
South Bend	100	100	Yes
Terre Haute	100	100	Yes
Wabash	100I	None	No
West Lafayette	100I	100-I	Yes
Winchester	100	100	....
Iowa:			
Albia	100	....	Not used
Boone	65	65	....
Cedar Rapids	100	100	....
Chariton	100	None	....
Charles City	100	....	Have none
Clinton	60	60	No
Creston	100	100	No
Davenport	100	100	Not used
Decorah	100	100	Gravel
Eagle Grove	100	100	No
Fort Dodge	100	100	Gra'l & ma.
Keokuk	100	100	Macadam
Muscatine	100	None	Gravel
Ottumwa	100	100 in best section, 10 to 50 in p.	None used
Sioux City	100	100	....
Spencer	100	None done	No
Waterloo	100a	100	No
Kansas:			
Atchison	100	100	No
Chanute	100	100	No
Columbus	100I	....	No
Fort Scott	100	100	....
Independence	100	100	Yes
Junction City	100I	....	Yes
Kansas City	100I	100-1	Yes
Leavenworth	100	....	Yes
McPherson	50	50	Yes
Paola	100I	....	Not used
Parsons	100	100	Macadam
Salina	100	100	No
Topeka	100I	66⅔	Yes
Wichita	100I	100-I	Yes
Kentucky:			
Ashland	100	None	No
Bowling Green	100	None	No
Corbin	100	None	Yes
Lexington	100	100	Yes
Paducah	None	None	No
Richmond	33⅓	33⅓	No
Maine:			
Augusta	None	None	....
Bangor	None	None	....
Gardiner	None	None	....
Lewiston	None	None	....
Portland	None	None	Yes
Rockland	None	None	No
Maryland:			
Hagerstown	33⅓	None	Sometimes
Massachusetts:			
Attleboro	None	None	....
Brockton	None	None	....
Easthampton	None	None	....
Fitchburg	None	None	....
Greenfield	None	None	No
Haverhill	None	None	....
Hudson	None	None	....
Lexington	None	None	....
New Bedford	None	None	....
North Adams	50	None	No
Peabody	None	None	Yes
Pittsfield	50	None	Only bit.ma
Rockland	None	None	....
Somerville	50 r	None	....
Waltham	50	None	Only bit.ma.
Webster	None	None	....
Worcester	Stone blk. & con., n'r; T. ma. 66⅔	None	No
Michigan:			
Ann Arbor	80	None	No
Bay City	70	70	No
Benton Harbor	100	100	No
Cadillac	100-I	....	Macadam
Detroit	100	None	No
Dowagiac	100-I	....	No
Flint	100-I	100-I	Yes
Grand Rapids	100	....	Yes
Hastings	70	None	No
Holland	100-I	None	No
Iron Mountain	None	None	....
Ironwood	None	None	....
Kalamazoo	100	100	No
Lansing	60	60-30	Yes
Midland	67	None	No
Mt. Clemens	100	None	No
Muskegon	100	100	No
Muskegon Heights	75	....	No

PAYMENT FOR REPAVEMENT

(Continued)

City	Percentage abutting property pays on Original pavement	Percentage abutting property pays on Re-paving	Are sand-clay, gravel or macadam classed as pavement?
Michigan (Continued)			
Negaunee	None	None	No
Niles	100-1	....	No
Owosso	60	40	No
Pontiac	83	None	No
Port Huron	100	all minus first cost	Yes
Saginaw	100-1	Same	Yes
Sault Ste. Marie	66⅔	....	....
Sturgis	100-1	....	No
Three Rivers	100	....	No
Minnesota:			
Albert Lea	100	100	No
Austin	100-1	....	No
Brainerd	100-1	66⅔	....
Crosby	100-1	None	No
Duluth	100-1	100-1	Yes
Ely	50	None	Yes
Fairmont	100	None	No
Faribault	100	None yet	No
Little Falls	75	None	No
Minneapolis	25-33⅓	25-33⅓	No
Montevidio	100-1	None	No
Owatonna	100-1	100-1	Yes
Rochester	100	100	No
So. St. Paul	25	None	No
Staples	100-1	100-1	No
Stillwater	100	....	No
Winona	100-1	100-1	Macadam
Missouri:			
Boonville	100	100	....
Brookfield	100	100	None used
Cape Girardeau	100	100	Yes
Carthage	66⅔-75	....	No
Clinton	100	100	....
Excelsior Springs	100	100	Yes
Fulton	100	100	No
Hannibal	100	100	....
Joplin	100	100	Yes
Kansas City	100	100	No
Kirksville	100	100	....
Maplewood	100	100	No
Marshall	100	100	Macadam
Monett	100	100	Yes
Poplar Bluff	100-b	100	No
St. Joseph	100	100	Macadam
St. Louis	100	100	....
Sedalia	100	....	No
Springfield			None
Montana:			
Anaconda	100	None	No
Billings	100	100	Yes
Bozeman	100	100	No
Butte	100	100	None used
Glendive	100-1	None	No
Great Falls	100	100	Yes
Helena	100	100	Yes
Kalispell	100	100	No
Lewistown	75-100	None	No
Livingston	100	....	None used
Nebraska:			
Columbus	100-1	....	No
Fremont	100-1	....	No
Grand Island	100	100	No
Hastings	100	100	No
Lincoln	100	100	No
Norfolk	100	None	Yes
North Platte	100	None	No
Omaha	100-1	100-1	....
Scottsbluff	100	....	No
New Hampshire:			
Berlin	None	None	....
Laconia	None	None	No
Nashua	None	None	No
Portsmouth	None	None	No
New Jersey:			
Bergenfield	100-1	None	Yes
Bridgeton	75	100	....
Camden	85-c	60-c	Not used
Cape May	None	None	....
Clifton	66-80	....	None used
East Orange	100	50 c	Yes
Edgewater	None	None	No
Freehold	20	None	No
Irvington	100-1	....	No
Jersey City	100	none	No
Long Branch	66⅔	None	No
Newark	95c	70-20 h	Yes
New Brunswick	100	None	None used
Newton	None	....	None
Passaic	60c	None	....
Phillipsburg	None	None	....
Plainfield	100	....	Macadam
Ridgefield Park	80-70 o	None	No
Roselle Park	50 c	....	....
Rutherford	None	None	Macadam

City	Percentage abutting property pays on Original pavement	Percentage abutting property pays on Re-paving	Are sand-clay, gravel or macadam classed as pavement?
New Jersey (Continued)			
Salem	None	None	No
So. Orange	66⅔	66⅔	No
Summit	Noned	Noned	Macadam
Trenton	10-50	None	No
Wallington	66⅔	....	....
West New York	65-75	None	None
West Orange	100	....	No
New Mexico:			
Albuquerque	100	None	No
Roswell	100	None	No
Santa Fe	100	....	....
New York:			
Amsterdam	50	50	No
Auburn	50	None	No
Binghamton	50	50	No
Buffalo	100	33⅓	No
Carthage	None	None	....
Cohoes	50	....	No
Corning	66⅔	66⅔	No
Cortland	66⅔	40	Macadam
Elmira	40	40	No
Endicott	50	....	No
Fulton	33⅓	None	No
Geneva	66⅔	66⅔	No
Glens Falls	50	None	Macadam
Gloversville	75	35	No
Gouverneur	None	None	Yes
Herkimer	66⅔	66⅔	No
Ithaca	16⅔	16⅔	No c
Jamestown	100	....	No
Johnson City	50	None	....
Johnstown	33⅓	33⅓	Macadam
Kingston	None	None	....
Lackawanna	50	None	Macadam
Lancaster	50	50	No
Little Falls	50	50	No
Lockport	66⅔	66⅔	Yes
Lynbrook	None	....	No
Massena	None	....	No
Newburgh	33⅓	None	No
N. Y.-Manhattan	100	None	No
Niagara Falls	100	None	....
No. Tonawanda	100	None	No
Ogdensburg	33⅓	33⅓	No
Olean	100	None	No
Oneida	66⅔	66⅔	No
Oneonta	66⅔	66⅔	Macadam
Port Chester	50	25	Yes
Poughkeepsie	33⅓	33⅓	Macadam
Rochester	100	100	Macadam
Schenectady	100	None	No
Syracuse	100	None	No
Watertown	50	50	No
Waverly	66⅔	....	No
North Carolina:			....
Asheville	33⅓	16⅔	....
Charlotte	100	None done	Macadam
Durham	33⅓	None	No
Greensboro	100	None	No
Mount Airy	25	None	Yes
Oxford	50	....	..
North Dakota:			
Fargo	100	100	None used
Grand Forks	80	80	None used
Mandan	100 m	....	No
Minot	80	....	No
Wahpeton	100	100	No
Ohio:			
Akron	98	50	Macadam
Alliance	98	50	Macadam
Ashtabula	98-1	50-1	Yes
Bellaire	98	50	....
Bellevue	98	....	No
Bucyrus	98	50	Macadam
Cambridge	98	50	....
Chillicothe	98	50	No
Cincinnati	98	50	Macadam
Columbus	98	50	None used
Conneaut	98	....	....
Dayton	98	98	Yes
Delaware	98	50	Yes
Elyria	33¼-1	50-1	No
Findlay	98	50	No
Granville	98	50	Yes
Greenville	None	50	No
Hillsboro	98-1	None	No
Ironton	98	50-1	....
Lakewood	90	50 or 33-f	....
Lancaster	85-1	50	No
Lorain	98	50	Macadam
Marion	98	50	No
Middletown	98	None done	....
Newark	98-1	50	No
Niles	98	50	Macadam
Oberlin	98	50	Yes
Ravenna	98	50	No
Salem	98	50	Yes
Struthers	98-1	98	Macadam
Tiffin	50	....	No
Troy		None done	No

PAYMENT FOR REPAVEMENT

(Continued)

City	Percentage abutting property pays on: Original pavement	Percentage abutting property pays on: Repaving	Are sand-clay, gravel or macadam classed as pavement?
Ohio (Continued)			
Warren	98	50	Macadam
Washington C. H.	98	....	Yes
Wooster	98	....	No
Zanesville	98	50	Yes
Oklahoma:			
Chickasha	100	....	None
Enid	100	100	None
Muskogee	100	80-I	Some cases
Norman	100	80	No
Sapulpa	100	....	....
Shawnee	100	80	Have none
Tulsa	100	....	No
Wagoner	100	None	....
Oregon:			
Ashland	100-I	....	....
Astoria	60-h	100	Yes
Corvallis	100	100	In parts
Dallas	100	100	Yes
Marshfield	100	100	None
Oregon City	100	100	Yes
Portland	100	100	Macadam
Salem	100	....	No
Pennsylvania:			
Allentown	100-I	None	....
Altoona	100	None	No
Bangor	33⅓	None	No
Berwick	66⅔	None	No
Blairsville	33⅓	....	Yes
Bradford	100-I	None	No
Butler	66⅔	None	No
Catasauqua	None	None	....
Chambersburg	33⅓	None	No
Clairton	100-I	None	No
College Hill	33⅓	None	No
Connellsville	100-I	None	No
Dale	None	None	....
Duquesne	100	None	No
Easton	No rule	None	No
Ellwood City	66⅔	None	No
Emporium	66⅔	....	No
Farrell	66⅔	None	No
Freeland	33⅓	33⅓	No
Greensburg	66⅔	None	No
Greenville	66⅔	....	No
Grove City	100-I	None	No
Hanover	66⅔	None	No
Harrisburg	100-I	None	No
Hazleton	66⅔	None	No
Huntington	33⅓	None	No
Indiana	66⅔	None	....
Jersey Shore	66⅔	66⅔	Macadam
Lebanon	100-I	None	No
Meadville	100-I	None	Macadam
Monongahela	66⅔	None	No
Munhall	66⅔	None	No
Nazareth	66⅔	None	Macadam
New Brighton	33⅓	None	No
New Castle	70	None	Macadam
North East	66⅔	None	No
Northampton	None	None	No
Oil City	100	None	No
Parkesburg	None	None	....
Perkasie	None	None	No
Pittston	33⅓	None	No
Pottsville	None	None	Macadam
Rankin	66⅔	None	No
Reading	None	None	No
Reynoldsville	66⅔	....	No
Ridgeway	33⅓	33⅓	No
Royersford	33⅓	None	No
Sayre	66⅔	50	No
Scranton	90	50	No
Sewickley	66⅔	None	No
Sharon	100-I	None	No
Sharpsville	None	None	....
Somerset	33⅓	....	No
Throop	66⅔	None	No
Tyrone	66⅔	....	No
Williamsport	100-I	None	No
Woodlawn	66⅔	None	None used
York	100-I	None	....
Rhode Island:			
Cranston	None	None	....
Pawtucket	None	None	....
Providence	None	None	....
Woonsocket	None	None	....
South Carolina:			
Charleston	100	g	No
Chester	50	None	No
Florence	66⅔	....	No
Greenville	50	None	No
Orangeburg	66⅔	None	No

City	Percentage abutting property pays on: Original pavement	Percentage abutting property pays on: Repaving	Are sand-clay, gravel or macadam classed as pavement?
South Dakota:			
Deadwood	None	None	No
Madison	100	....	No
Sioux Falls	100	None done	No
Tennessee:			
Clarksville	33⅓	None	....
Cleveland	⅔ of pav. / proper I	None	Yes
Dyersburg	66⅔	....	No
Murfreesboro	66⅔	....	No
Trenton	None	None	....
Texas:			
Amarillo	66⅔	None	No
Ballinger	66⅔	....	No
Beaumont	55	....	No
Bonham	33⅓	....	Yes
Cleburne	100-I	Some	No
Corpus Christi	75-I	....	....
Denton	66⅔	66⅔	Mac. & Gra.
Eastland	33⅓	....	No
Mexia	75	None	....
Mineral Wells	100	None	Yes
Navasota	33⅓	....	Yes
Paris	33⅓-I	33⅓	No
San Angelo	10	None	No
Tyler	66⅔	None	No
Weatherford	33⅓	None	No
Utah:			
Brigham	100	None	No
Logan	100-I	....	....
Provo	100	100	No
Salt Lake	80	80	No
Vermont:			
Barre	50	None	Macadam
Bennington	None	None	....
Rutland	None	None	No
Virginia:			
Danville	None	None	No
Washington:			
Aberdeen	100	....	Yes
Dayton	100	100	Yes
Mount Vernon	100	100	No
Olympia	100	....	....
Puyallup	100	None	No
Raymond	100	....	....
Seattle	95	100	Macadam
Walla Walla	100	None	....
Yakima	100	....	....
West Virginia:			
Bluefield	100-I	100-I	Yes
Charleston	100	50	No
Clarksburg	100-I	100-I	....
Fairmont	66⅔	None	No
Morgantown	100	100-t	....
Wisconsin:			
Beloit	100-I	100-I-u	Yes
Delavan	100	....	....
Green Bay	100-I	....	....
Janesville	100-k	100-k	Macadam
Kaukauna	100-I	None	No
Lacrosse	100	50	....
Lake Geneva	100-I	....	No
Manitowoc	50	50	No
Marinette	65	None	Yes
Menominee	57.7	None	No
Merrill	66⅔	66⅔	Yes
New London	66⅔	None	No
Norwalk	50	None	Macadam
Ripon	33⅓	None	No
Sheboygan	66⅔	u	Yes
Stevens Point	100-I	100-I	No
Tomahawk	100	....	No
Waukesha	100	....	No
Wausau	50	....	....
Wisconsin Rapids	66⅔	66⅔	No
Wyoming:			
Casper	100	None	Yes
Sheridan	100	100	No

a—Except where valuation is too low to admit of full assessment. b—Assessment zone extends ½ the distance to the next parallel street. c—Approximate. d—If ordered by common council, abutting property assessed according to benefits received; otherwise city pays whole cost. e—Unless some other type of pavement is laid over old macadam. f—50% if pavement is more than 20 years old; 33% if less. g—None during 20 years, all after 20 years. h—70% on residential streets, about 20% on thoroughfares. i—Exclusive of intersections. k—Up to $3 per sq. yd. l—Except sub-grading. m—Side assessed back 150 ft.; first 50 ft. 70%, next 50 ft. 20%, next 10%. n—Flat rate per front foot, $1.00 for wood blk., 75c. for concrete, 60c. for asphalt on concrete base and 50c. on old macadam base, and 40c. for bituminous macadam. o—80% amesite, 70% concrete. p—Up to a width of 40 ft. r—Tar macadam only. s—If built under the Special Improvement District plan. t—After 15 years. u—Up to $3 a sq. yd.

Paving Across Indiana Marshes

During 1922 the state of Indiana, assisted by federal aid, built a considerable part of a highway from Gary, Indiana, to the Michigan state line over what is known as the "Dunes Highway," the total length of which will be about 25 miles. Near the west end of the job the road crosses a long marsh and then cuts across alternate sand ridges and marshes. In these swampy areas there is a layer of peat on top of the fine dune sand.

The first two or three miles of the pavement is constructed on a fill about 5 feet deep placed directly on the peat bog. To secure material for this fill a ditch was excavated along the side of the embankment with an Osgood convertible shovel and dragline. The peat or muck removed from the top was used to build up shoulders of the embankment and the sand removed from below was placed upon the roadway. Part of the fill was sufficiently far from the ditch to make it safe, in the opinion of the engineers, to lay the pavement at once, but the western 4,500 feet of the embankment was left unpaved through the winter to permit any uneven settlement to take place before paving. In this section test pits were dug through the fill to the original ground at a number of points at which levels had been taken in cross sectioning, and a small opening to the old surface was left lined with boards so that future settlement could be determined by levelling. In addition, soundings in the ditch will be made, to learn whether the subsoil is being pushed sideways by the weight of the embankment. Last winter the contractor on this section, The General Construction Company of Gary, Indiana, carried on some heavy grading so that concreting can be started early in the Spring.

In laying pavement on the fills across the marshes, bar reinforcement weighing 56 lbs. per 100 square feet is used, but elsewhere a plain 1-2-3 concrete slab is specified. The highway is made 20 feet wide throughout, 7 inches thick at the sides and 8 inches at the center. No expansion joints are used. Five ⅝-inch round rods are used at each construction joint as dowels to keep the joints even, these bars being wrapped to prevent bonding with the concrete.

The concrete is finished with Lakewood finishing machines. The fresh concrete surface is tested with an 8-foot straightedge and any inequalities remedied at once.

Water supply was obtained by driving to a depth of 10 to 15 feet five sand points, each consisting of a pointed cylindrical screen 2½ inches in diameter, connected to a pump by 1½-inch pipe. All material had to be distributed by industrial railway as there was no existing road for part of the distance and the fine sandy soil made trucking out of the question.

Sand for New Hampshire Highway Construction

The state of New Hampshire has made a study of its native road-building material more thorough and scientific probably than any other state in the Union, this study having been begun in 1917. It is now practically completed although presumably an investigation of special materials or uses of materials will be continued by the state highway geologist, who has been making these studies.

Stone, gravel and sand are about the only road building materials in the state, except silt and clay that may be used for asphalt pavements. There is very little rock in the state that furnishes a first-class road building material. Gravel, however, is very common and there is considerable sand. Of the samples of the various materials submitted and tested by the state testing engineer, 80% of the rock samples were found unsuitable and 70% of the sand samples, while only 11% of the gravel samples were unsuitable.

A general survey of New Hampshire sands was begun in 1921 and considerably extended in 1922, in accordance with a co-operative agreement between the state highway department and the U. S. Bureau of Public Roads. During the past year the greater part of the field work was given to the study of sand deposits and collections of sand samples for testing by the state laboratory. New Hampshire sands are considered to be more variable in mineral composition and in other physical characteristics than those of most states and are especially rich in feldspar. The general presence of feldspar perhaps explains the very large number of failures in tests of tensile strength of concrete made by the state laboratory.

The mineral composition of the sands is studied under the microscope and compared as to percentages of quartz, feldspar, mica, slate chips, etc., and the strength of concrete made with the various samples is compared with these analyzes. One fact of practical importance that has been learned from the tests is that sands rich in slate splinters show almost without exception a high tensile strength. The state highway geologist reports that "this is surprising, inasmuch as slate chips are both soft and cleavable; and must be due to the effect of needle-like or lath shape splinters of slate becoming interlaced in the mix and so reinforcing the concrete. Practical concrete workers have been inclined to reject such sands as these on the ground that they are 'dirty,' that is, dark colored, and not 'sharp.' Without our laboratory tests, therefore, we would have been in danger of condemning slaty sands, which are among the best we have."

Transportation Survey in Connecticut

The Bureau of Public Roads and the Connecticut State Highway Department in September of last year began making a survey of transportation conditions in that state which is the most complete of its kind ever undertaken, it is believed. There are two branches of the traffic survey, one an intensive survey taken at eight key points throughout the state, the other an extensive survey taken at fifty-six stations. Observations were made at each intensive station for an entire week every two months, and these observations will be continued for a period of a year, obtaining records of seasonal variations of traffic. The observations at the fifty-six selected

stations are made for one day in each month. The fifty-six stations are divided into eight districts, one surrounding each of the eight intensive stations.

The observations made at the intensive stations relate to truck traffic only. Every truck passing the stations during the period of observations is stopped, weighed and measured and the make and capacity of vehicle, the commodity it carries and its origin and destination are determined, frequency of its trips and whether it is engaged in a public trucking business or is operated privately.

At the extensive stations both passenger and truck data are obtained, these including the number and make of each car, number of passengers, capacity and cargo of trucks, origin and destination, number of trips made by trucks each week and time required per trip, and whether the passenger cars are operated for business or pleasure.

The results of the survey for the entire year will, of course, not be available for several months yet, but information collected during the first few months gives the following results:

During the three months from September 11th to December 2nd, approximately one-quarter of the total motor truck net tonnage was transported over the highways for a distance of 9 miles or less, one-half of it from 10 to 69 miles and one-quarter of it 70 miles or more. Of the passenger vehicle movement, 35% was for business purposes and 65% for recreation. When used for business the number of passengers per vehicle averaged 1.7, and 3 when used for recreation. The average business mileage was 29.7 and the recreational mileage 55.5.

Comparing the seasons, in January and February the motor truck traffic showed 40% decrease below that for October and the passenger vehicle traffic a 68% decrease. Weights of the loads of 10,465 trucks between September 11th and December 2nd showed 29.6% overloaded beyond their rated capacity. There was apparent a tendency to increase the percentage of overloaded truck bodies as the width of load increases.

Per Capita Consumption of Cement

An interesting statement of the per capita consumption of cement in each of the states of the Union, together with figures for total consumption, has been made public by the Portland Cement Association. The figures supplied show that during 1922 there were shipped into the several states 115,263,000 barrels of cement. The maximum number going to any one state was 13,212,000 to New York, with 10,343,000 to Pennsylvania and 9,649,000 to Illinois. The minimum quantity was 91,000 barrels to Nevada and the next smallest 229,000 to Wyoming.

The average amount per capita to the entire United States was 1.06 barrels. The maximum per capita was 2.19 barrels to California and the next was 1.76 to Arizona, followed by 1.69 to Wisconsin and 1.60 to Delaware. The smallest per capita was .23 to Mississippi and the next smallest .28 to Arkansas.

The per capita consumption in 1922 far exceeded that of any other year, the figures for 1920 and 1921 being 0.87 each year, the figure for 1919 being 0.77 and the figure for 1918 0.65.

Municipal Testing Laboratories

Essential duties and value of a material testing laboratory to a city.

The "Rochester Engineer," the monthly publication of the Rochester Engineering Society, contains in its February issue the prize competition essay of the Society for 1922 written by H. L. Howe, Jr., entitled "The Value of a Material Testing Laboratory to a Municipality." The essay certainly makes a strong claim for such a laboratory, some of the most important items of which are briefly abstracted below:

"The essential duties of a municipal testing laboratory may be briefly outlined as follows:

"1. To develop or adopt uniform standards and specifications. 2. To establish a fair and scientific basis for the purchase of materials and supplies. 3. To check the qualities of the materials purchased. 4. To advise as to the proper usage of materials and control manufacturing processes. 5. To reduce the risk costs to both the contractor and the city. 6. To aid in the advancement of the knowledge of materials."

Concerning standard specifications, he recommends the adoption of those which are widely accepted rather than others, no matter how meritorius, that are prepared by employees of a given municipality, since the former most fully eliminate a great deal of undesirable controversy and result in greater efficiency in expenditure of public funds, while less objection can be offered to their provisions than if they were employed by one or two cities only.

"By furnishing contractors with information as to the character of materials from various sources, the laboratory can to a large extent reduce the risk cost to both the contractor and the city and to a large extent prevent the delivery of inferior materials to the site of the work." It also performs a service to the honest contractor by making it difficult for unscrupulous contractors to underbid their competitors. Standardized specifications for materials for municipal work will often be copied by local industries, thus benefiting them and tending toward a standardizing of the materials purchasable in the local market.

"Besides the routine testing of such construction materials as cement, concrete aggregates, asphalt cement and pavement aggregates, building and paving brick, asphalt block, tile, etc., the laboratory should investigate and inspect local sources of materials such as sand and gravel pits, stone quarries, brick and tile yards, and particularly the asphalt pavement mixing plants."

The laboratory should serve not only the engineering department, but also the city's school, building, fire, police, water, purchasing and other bureaus, shops, garages and utilities. For example, it should determine the value of the city's fuel, gasoline, grease solvents, garbage grease and tankage, soap, fire hose and boots, lubricants, paper, paints and other products that can be bought on almost absolute merit.

Recent Legal Decisions

CITY'S REPAYMENT OF DEPOSIT AGAINST FORFEITURE OF FRANCHISE HELD VALID

A municipality conferred a franchise upon a depot and terminal company, authorizing it to occupy the city's streets and property for the construction of a union depot and terminals, the construction to begin within one year from a fixed time. The franchise provided for a deposit by the company, which would become the property of the city if at any time the franchise was forfeited. Differences arising between the parties, relating to the existence of the city's right to forfeit for noncompliance with the terms of the grant, the city council later revoked the franchise, and in the revoking ordinance authorized the return of the deposit to the company. The Ohio Supreme Court, Cincinnati Union Depot etc., Co. v. City of Cincinnati, 137 N. E. 14, holds that under these facts the return of the deposit was not a gift by the city, and its repayment was within the power of the city council.

CONSTRUCTION OF WATER FRANCHISE ACQUIRED BY ANOTHER MUNICIPALITY

The Pennsylvania Supreme Court holds, City of Bethlehem v. City of Allentown, 118 Atl. 643, that the construction for several years of a water company's franchise as giving the company the right to supply a municipality with water cannot be questioned, except by the commonwealth, even where another municipality has acquired the franchise. The court suggests the desirability of legislation permitting municipalities so situated to move for condemnation and valuation of the property involved, including the franchise value.

MUNICIPAL CORPORATIONS NOT LIABLE IN DAMAGES FOR FAILURE TO LIGHT STREETS

The Minnesota Supreme Court holds, Bojko v. City of Minneapolis, 191 N. W. 399, that the authority conferred upon the city to light its streets and other public places is governmental in character, is permissive, not made an absolute duty, and a negligent performance thereof, or a failure to perform at all, does not render the municipality liable in damages. The nonliability of the municipality in such cases is the prevailing rule in this country. The city is therefore not liable for an injury caused by such failure.

MUNICIPAL CORPORATIONS NOT REQUIRED TO LIGHT STREETS OR BRIDGES

The laws of Iowa do not require cities and towns to light their streets. The Iowa Supreme Court therefore holds, Shannon v. City of Council Bluffs, 190 N. W. 951, that it is not negligence to fail to do so unless the condition of the street is such that reasonable care on the part of the city would require that it be lighted.

TOWNSHIP AND ITS OFFICERS NOT LIABLE FOR INJURIES FROM DEFECTS IN HIGHWAY

The Nebraska Supreme Court holds, Pester v. Holmes, 191 N. W. 709, that a township organized under the township organization act in that state is not liable to persons injured by defects in the public highways within the limits of such township. Its duty is to keep the highway in repair, a governmental duty for the negligent performance of which it is in no way responsible to private individuals. This exemption of the township from liability extends to its officers, agents and servants in the prosecution of work upon the highway.

NEBRASKA—PUBLIC ROAD ACQUIRED BY TEN YEARS' USE

The Nebraska Supreme Court holds, Lee v. Everly, 191 N. W. 699, that where a public road has been attempted to be established by proceedings under the statute and opened and traveled by the public for more than ten years, the public thereby acquires an easement therein, and the court will not examine the original proceedings for the laying out of the road and determine whether or not they are valid.

SALE BY CITY OF VACATED STREETS BELOW ACTUAL VALUE

The Nebraska Supreme Court holds, Karlin v. Franciscan Sisterhood (City of Columbus, Intervener), 192 N. W. 122, that when the charter of a city of the second class gives authority to the mayor and city council to sell vacated streets, a sale of such vacated streets by the city should not be set aside merely because the selling price may not equal the actual value, unless such selling price is so grossly inadequate as to cause a presumption that there was fraud, or that the mayor and council had not acted in good faith.

CITY'S REMEDY AGAINST THIRD PARTY IN DEFAULT FOR DAMAGES TO INJURED PERSONS

The North Dakota Supreme Court holds, Keller v. City of Fargo, 192 N. W. 313, that a municipal corporation required to pay damages to a person injured on its streets (in this case by falling over frozen dirt piled on each side of the sidewalk by an independent contractor after filling in an excavation), unless the corporation is also a wrong-doer, has a remedy over against the third person who is at fault.

POWER TO REQUIRE PERMITS FOR OPERATION OF QUARRIES IN MUNICIPALITIES

In an action to restrain the enforcement of an ordinance of the city of Minneapolis requiring a permit for the operation of stone quarries, the Minnesota Supreme Court holds, Meyers v. City of Minneapolis, 191 N. W. 609, that under the general welfare clause of the charter of Minneapolis its common council may require a permit for the operation of a stone quarry within its limits. The owner of such a quarry must have a permit before operating, and without applying for it he cannot have an injunction against the enforcement of the ordinance requiring it. The ordinance is held valid on its face. If the quarry owner is wrongfully denied a permit, he has a remedy. The power of regulation resting in the city is extensive, but must be exercised within constitutional limits.

PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 54 July, 1923 No. 7

Expediting Drying of Sewage Sludge

Initial de-watering of sludge by the use of alum with subsequent drying on stone beds. Experiments at Plainfield, N. J., plant reduced drying period, to less than one-third, even in wet weather.

In his report to the Plainfield, N. Plainfield and Dunellen Joint Sewer Meeting (the name given to the combination of municipalities that built and operates a sewage treatment plant at "Green Brook Park," N. J.) for the quarter ending May 31, 1923, John R. Downes, superintendent of the disposal works, discloses that working in co-operation with the New Jersey State Sewage Substation, he has been able to point out a principle of sludge treatment which has evidently escaped notice because of its very simplicity.

Every chemist considers thorough mixing of reagents almost essential to every reaction and the water chemist, familiar with the use of alum in treating water, knows the value of prompt and vigorous agitation in obtaining results. It is not strange, therefore, that those who have sought to treat sludge with alum have sought to obtain thorough mixing by means of agitation The investigation at Plainfield was proceeding along these lines with somewhat indifferent though promising success, when the superintendent suggested that his long experience with sludges led him to believe that the violent agitation was undoing the work of the alum and even destroying the original tendency of the sludge to become drainable. Mixing was gradually cut down to what was considered a minimum with constantly improving results. After the supposed minimum had been reached the accidental misplacing of a barrel by a laborer lead to a further cut in agitation with great improvement in results and a cutting of the amount of alum required to a negligible quantity. Finally a stream of alum solution (100 pounds to 50 gallons of water) was allowed to run into the stream of flowing sludge just as the sludge left its channel to enter the drying bed. The reaction was completed in the bed itself, in com-

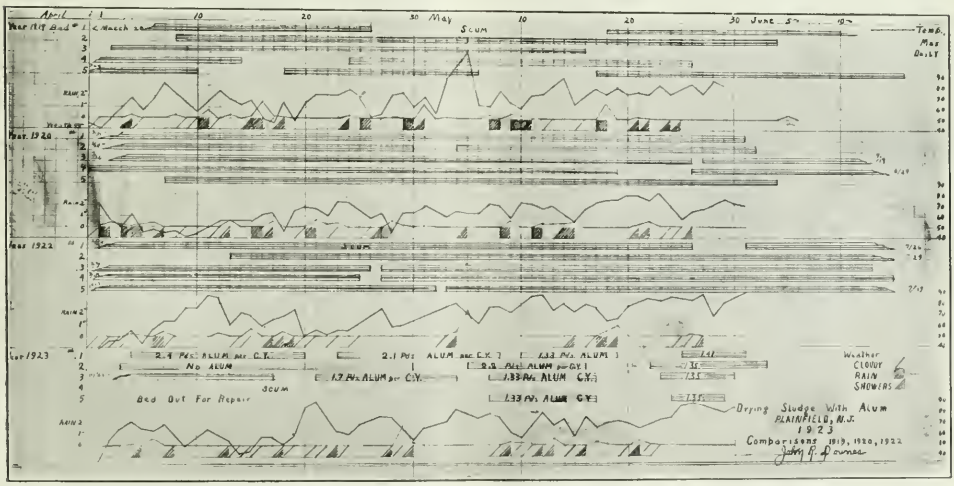


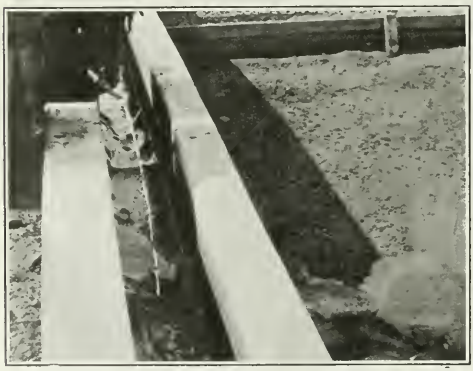
CHART SHOWING LENGTH OF TIME REQUIRED TO DRY SLUDGE TO A FORKABLE CONDITION. The length of bar shows the number of days required for drying on each bed and with the amount of alum used as shown by figures on the bar. Records for 1919, 1920 and 1922 are shown for comparison.

parative quiescence. The sludge instantly congealed to a lava like consistency and free water ran out at the edges in the course of about twenty minutes.

The accompanying chart shows the length of time required to dry sludge to a condition in which it can be picked up on a stone fork with tines ¾ inch apart and removed from the bed. On the bars indicating the drying time in days for the year 1923, is indicated the dose of alum in pounds per cubic yard of sludge removed from the Imhoff tanks. The other years are shown for comparison, the year 1921 being omitted because no sludge was drawn at the corresponding period due to repairs to concrete. Weather conditions have been indicated on the chart.

More significant than the very short drying periods in the fair weather at the end of May, at a time when the necessity of minimum agitation was fully appreciated, is the success of the first treatment shown with rain on the freshly drawn sludge the day it was drawn and also the following day; a condition which would have required a great deal of time to overcome had the sludge not been treated. The check, drawn the previous day, escaped rain for nearly 48 hours at the start.

In fact this matter of making the sludge very largely independent of rainfall even during the first 24 hours is of great value. We have succeeded in drying sludge without treatment in from ten days to two weeks in perfect drying weather. Such weather, however, is not to be depended on over any extended periods and the result is that during six years of operation the average number of dryings per bed per year has been slightly under six. On the other hand, between April 4 and June 1, 1923, we completed four dryings of treated sludge on one bed. Taking the drying season as from April 1 to Nov. 1, or 214 days, 6 dryings per year equals about 33 days per drying as compared with an average of ten days per drying in the 11 dryings charted in 1923. These figures are averages and it has not been uncommon to have a bed tied up for 60 or 70 days with one dose of sludge.



ALUM SOLUTION IS ADDED TO SLUDGE JUST AS IT LEAVES TROUGH TO ENTER BED

The factor of chief interest to the three municipalities connected with the Joint Sewer at this time is the saving of from $8,000 to $10,000 which it had been planned to spend on new sludge drying beds. And this saving is accomplished at a cost of $100 per year for alum. Previous to 1923 it had never been possible to draw sludge as fast as it collected and ripened and each oncoming winter found an accumulation of sludge in the digestion tanks. In 1923 the second week in June found the digestion tanks free of all the sludge which it was thought practicable to move without upsetting the digestion balance.

Application of the alum is simplicity itself. We know that we draw from the digestion tanks 110 cubic yards of sludge and that it takes about two hours to run this to the beds. A dose of alum for 110 cubic yards of sludge (roughly 150 pounds) is weighed up and put in two gunny sacks and one of the sacks suspended at the top of each of two barrels. The barrels are filled with water at night and in the morning the solution is found to be completed. The solution is stirred and kept stirred to make it uniform, and the flow adjusted so that the entire quantity of solution will be discharged in the same time period which it takes to draw the sludge. Irregularities in the flow of sludge are compensated for by the comparatively large size of the beds in which the reaction is completed.

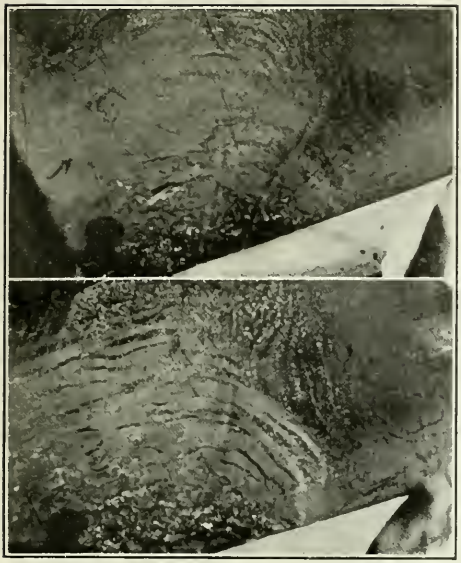
The number of cubic yards of sludge removed from the tanks is calculated by measuring the depression of the water surface of the tank during the operation. In the case of the local sludge, a dose of 1.35 pounds of alum per cubic yard of sludge is sufficient. This equals about 1½ pounds of alum to a ton of sludge.

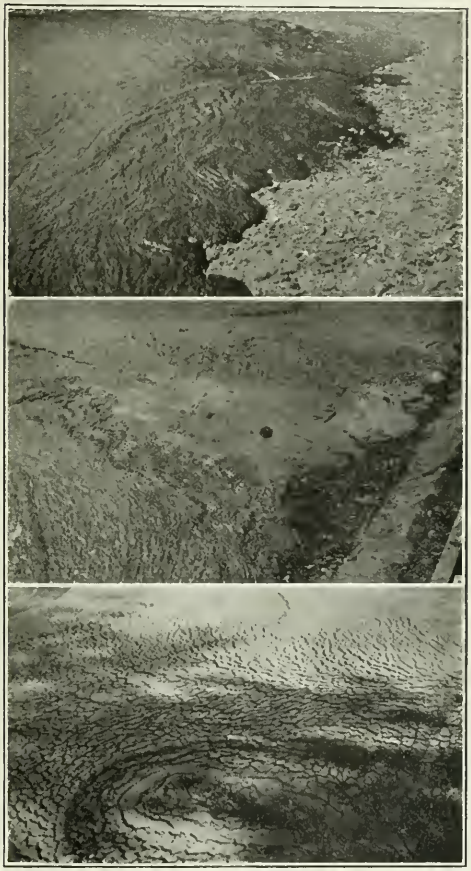
There is nothing critical about the dose and the expense is so small in any case that the method of treatment is available to all.

The treated sludge seems to be slightly less in volume when ready for removal from the bed, and is of a better texture for handling, being more fibrous and separating more readily from the material of the bed. This difference in physical texture between treated and untreated sludges is much more marked than the difference in moisture content (by drying at 105°C) which often seems negligible.

Mr. Downes, whose mail address is Bound Brook, N. J., is a member of the Research Committee of The N. J. Sewage Works Association and would appreciate the receipt of reports on the use of alum for sludge dewatering for the use of the Association, which has been strongly backing the experimental work of the sewage sub-station. To determine whether or not a sludge requires alum to assist in dewatering, take a sizeable sample in a glass jar. If clear liquid separates out at the exact bottom of the container, alum will probably be of little assistance. If, however, the liquid is murky or separates out at any point other than at the bottom, there is every reason to believe that alum will be beneficial.

Alum can be obtained in ten lots at about $1.75 per hundred, which makes the cost about $30 per year for each million gallons daily plant treatment.





LEFT-HAND COLUMN

Top—When dose of alum is sufficient, sludge at once curdles and becomes semi-solid, as shown here.

Middle—This shows the alum dose cut off, producing a watery surface that ripples freely as compared with the viscous, wrinkled appearance seen in the cut above.

Bottom—The concentric rings shown in the other photographs finally form great sweeping curves, along which cracking later occurs. To get the second picture the alum flow had been momentarily cut off. The effect a few moments later is seen in the bottom picture. The meandering streak with big surface bubbles at the center of the picture is the rippling flow without alum. On either side of this streak adequate alum treatment had been supplied.

RIGHT-HAND COLUMN

Top—Shows edge of creeping flow of treated sludge upon the bed and the crinkled surface.

Middle—The grey, V-shaped patch in the center is water draining out ahead of the slowly creeping mass of sludge at the end of the bed farthest from the outlet. Water begins to separate out at the edges 20 minutes after treatment is begun.

Bottom—Five hours after the bed had been filled with treated sludge, cracks developed as shown in this picture.

Activated Sludge Process

Principles and recent developments. Intermittent aeration. Mechanical aeration. Sludge de-watering and drying. Fertilizing value of sludge. Effluent for fish ponds.

An excellent, concise and clear account and description of the development and principles of the activated sludge process of sewage treatment was contributed by Prof. Edward Bartow, of the State University of Iowa, to a symposium on sewage treatment at the Fourth Conference on Sewage Treatment at Iowa State College. After giving a brief history of the experiments at the Lawrence station and the development of this process in England and later in this country, with which the readers of this paper are familiar, Prof. Bartow continued as follows:

The features of the process which have delayed its development are the cost of compressed air and the satisfactory drying of the sludge. Attempts have been made to decrease the cost of the air by using an intermittent flow, by so arranging the bottom that the minimum amount of air required for stirring may be used, and by methods of mechanical aeration.

The intermittent use of air has been tried in England, but without great success. Activated Sludge Limited, the English company which claims ownership of the English and American patents on the process, have devised a scheme at Manchester, England, in which diffuser plates are placed along one side of a long tank in such a manner that circular currents are set up. The liquid is kept saturated with sufficient air to support bacterial life, and the current is great enough to keep the sludge in suspension and prevent putrefaction. A comparative test made on the waste from a starch factory at Argo, Illinois, indicates a saving of at least 25 per cent of air by this arrangement.

MECHANICAL AERATION

The most successful system of mechanical aeration has been devised by Haworth, superintendent of the sewage-disposal works at Sheffield, England. He first used a box in which was installed a cylindrical mechanism which revolved at the surface of the liquid, partially submerged. The liquid was kept agitated by the mechanism and sufficient air carried into the liquid to support the bacterial life. Haworth's next scheme was by the use of a vertical shaft around which paddles, revolving, keep the liquid in motion through a long series of tanks. This was followed by the construction of a plant intended to handle 1,000,000 gallons of sewage per day, consisting of a long series of tanks four feet wide and four feet deep, with paddle wheels at intervals to carry the sewage and sludge at a sufficient rate to keep the sludge in suspension. This plant has been in operation for nearly two years with satisfaction. It is claimed that it will operate at a cost of twenty horse-power per 1,000,000 gallons for the other process stirred with air. With the approval of the British Board of Health, plans have been made for the construction at Sheffield of a plant of 15,000,000 Imperial gallons capacity. The first unit of two and one-half million gallons capacity will be in operation by March, and will be installed on the site of the contact beds which have become inadequate for the disposal of Sheffield sewage. The process in use at Sheffield has been imitated by the engineers of the city of Paris, France, for an experimental plant of 1,500,000 gallons capacity. The French engineers gave careful consideration to all processes and have constructed the mechanical aeration of the Haworth type. When I saw the plant in August, 1922, it had been in operation about six weeks and was furnishing, without odor, a clear stable effluent, much to the delight of the French engineers. John Watson at Birmingham, England, after preliminary tests has determined to use the Haworth type of mechanical filtration. It is his plan to partially purify sewage by activated sludge, and to finish the process by passing the effluent from the activated-sludge plant to the sprinkling filter beds which have been in operation for many years.

Another scheme for mechanical aeration has been devised by Joshua Bolton, of Bury, England. Mr. Bolton has used settling tanks of the old Bury system. In the center of tanks about twenty-four feet in diameter he has built wells of sheet iron three and one-half feet in diameter, extending nearly to the bottom of the tank. At the upper part of these wells he has placed a flange extending from a few inches below the surface of the water to a few inches above. Vanes are fastened to a vertical shaft revolving in the flange and carry water from the surface of the tank and throw it in a spray over the surface of the water in the tank outside of the well. Near the circumference of the tank is suspended a baffle which prevents the spray from being thrown to the outside of the tank, directs the mixed sludge and sewage towards the bottom and allows the clarified effluent to flow up on the outside into the outlet trough. In one tank a sloping bottom carries the settling sludge under the central well. In another a slow-moving mechanism, consisting of radial arms with plows, carries the sludge beneath the central well. Preliminary tests with this mechanism have been so satisfactory that the British Board of Health has authorized the construction of a larger plant. It is claimed that the cost of operation may be reduced to fourteen horse-power per 1,000,000 gallons, compared with the twenty horse-power claimed for the Haworth process and the thirty-five estimated for the diffuser process.

In the United States large plants using the diffuser scheme have been constructed at Houston, Texas, and in Chicago, Illinois, at the Maywood plant, and are being constructed at Milwaukee, Wisconsin, and Indianapolis, Indiana, and have been authorized for Chicago, Illinois, north side. Smaller plants are in operation at various points. At Mason City, Iowa, a plant has been installed for the treatment of waste from a packing house. I designed the plant to take care of the waste when one thousand hogs per day were being slaughtered. The plant consists of rectangular tanks containing aerators and a circular tank with a Dorr clarifier to allow the sludge to settle and from which it can be returned to the aeration

tank. When not overloaded this plant has operated successfully and the sludge has been dried and used in the by-products department.

No use has as yet been made in the United States of the mechanical principle. The mechanical device used at Sheffield would require much larger land areas than would be required for the diffuser process, and the cost of land might in some places prevent the use of the mechanical process.

THE SLUDGE PROBLEM

The second difficulty mentioned above, the dewatering and drying of the sludge, has been an object of investigation both in England and in the United States. Where the plants are running on an experimental basis at Manchester, the excess sludge is allowed to pass into the tanks or on to the drying beds used in the main process. At Worcester considerable land areas are covered with the sludge. Since the sludge contains from 98½ to 99½ per cent of moisture, and since it settles slowly and dries with difficulty, the disposal of sludge is a very serious problem. Centrifugal machines will reduce the moisture to approximately 90 per cent. The ordinary plate and frame filter-press will reduce the moisture to 79 or 82 per cent in the summer time. Experiments in the winter have often failed, unless the sludge has been warmed and treated with sulphuric acid or with alum. The best results have been obtained when the sludge has been warmed to a temperature of 150° F., and treated with sufficient acid or alum to cause the flocculent material to coagulate into larger masses. The best results obtained in America have been with an Oliver or American filter. These filters give a layer of sludge a little less than one-fourth inch thick, which will dry easily in the open air. The pressed cakes from a plate and frame press are one to one and one-half inches thick and when placed in the dryer are dried on the outside into an impervious layer which holds the remaining moisture inside. The rotary direct-heat dryers have been used for drying at Houston, Texas, without success. It is claimed that the experimental dryer at Milwaukee is satisfactory, and the Sanitary District of Chicago has installed a rotary dryer in its Maywood plant. The Maywood plant is about ready to operate and we will have some information concerning its operation in the near future.

An indirect-heat dryer manufactured by the Bayley Manufacturing Company has been used experimentally. The pressed cake used was too thick for satisfactory operation, and it is my belief that with the material obtained by the Oliver or American filter satisfactory results can be obtained with this apparatus.

The dried sludge obtained in the activated-sludge process contains from four to eight per cent nitrogen. This sludge has been tested by the approved methods for analyzing nitrogen and has been shown to be valuable as a fertilizer. It has also been tested by Lipmann in California, who states that the nitrogen is of the same grade as tankage for fertilizing purposes. With Mohlman, and later with Hatfield, I have made pot cultures on wheat and garden cultures on vegetables, and have shown that the nitrogen is in a form available to support plant life. Calculations from the pot cultures of wheat show a yield of nine bushels per acre when no fertilizer is used, and thirty-six bushels per acre when pots were fertilized by activated sludge. These experiments have been repeated by Nasmith at Guelph, and our results corroborated. Russell and Richards, at the Tothamsted experiment station in England, have shown that the activated sludge is valuable as a fertilizer. I visited Sir John Russell during the past summer, and was told that he had no doubt of the fertilizing value of the sludge. The next step was for the engineers to find a satisfactory method for drying the sludge. He would then use it in large scale demonstration tests to show its value to the farmers of England. The workmen at the Sheffield sewage-disposal plant have used activated sludge in fertilizing their gardens. These workmen took all the prizes for which they could compete at the Manchester garden exposition. They took the district prizes and the general prizes, twenty-seven in all.

Usually it is necessary to place grit chambers and screens in the purification plant ahead of the activated-sludge plant. Screens of any kind can be used, but we have had some experience with the Dorrco screen at the experiment station at Urbana, Illinois. The sewage enters a tank in which a cylindrical screen revolves at such a rate that screened sewage on the inside of the screen is drawn above the level of the unscreened sewage outside and flows out through the screen, automatically cleaning the screen. Screens of this type have been successfully used in the screening of tannery waste.

It has also occurred to me that the effluent from the activated-sludge plants might be used to form fish ponds. Fish ponds have been in operation at Strassburg, France, for about ten years. The effluent from settling tanks mixed with two or three times its volume of river water will support fish life. The activated sludge effluent is so much better that it should be satisfactory without dilution.

There has recently been published by the State Water Survey of Illinois a Bulletin (No. 18) describing investigations on activated sludge, conducted by the Survey during 1921 and 1922 and especially on tanks of the Dorr-Peck design. Owing, we believe, to the uneconomical features of this plant, the Dorr company has "given up any further work with this process," but the investigation developed several valuable conclusions relative to the activated sludge process.

One of the conclusions from these experiments, combined with others, is given in the bulletin in the form of a statement concerning the mechanism of the activated sludge process, as follows:

Activated sludge flocs are composed of a synthetic gelatinous matrix, similar to that of Nostoc or Merismopedia, in which filamentous and unicellular bacteria are imbedded and on which various protozoa and some metazoa crawl and feed. The purification is accomplished by ingestion and assimilation of the organic matter in the sewage by organisms, and its resynthesis by them into the living material of the flocs. This process changes organic matter from colloidal and dissolved states of dispersion to a state in which it will settle out.

Another conclusion is that, "unless the cost of operation can be very materially reduced or considerable

return realized on the sludge, the process will be of very limited application."

Rochester's Brighton Sewage Disposal Plant

The city of Rochester in 1916 completed a sewage disposal plant consisting of racks, grit chambers, Imhoff tank, sludge beds, dosing siphon, sprinkling filters and final settling basins, having a capacity for 15,000 people and parts of it for 30,000, although at present the population contributing sewage is only 8,000 or 9,000, and the plant is handling a little over one million gallons per day.

During 1922, 97.2% of the settling solids and 60% of the suspended solids were removed by the Imhoff tank; and the ultimate removal of suspended solids of the entire plant averaged 91.9%.

The site of this plant has been landscaped by the park department and is a popular picnic resort. In June it is surrounded with prairie roses, masses of shrubbery are planted along one side of the main drive and flowers on the other side, while through the trees is obtained a view of the bay a mile to the north. The total cost of the plant was $119,451, which includes $28,708 for the site, piping, etc. Concerning this plant John F. Skinner, Deputy City Engineer, a few weeks ago said: "This was the first one of our municipal sewage disposal plants completed. Its successful operation, dating from March 1, 1916, has justified the design of the plant, which has been intelligently operated under expert technical control so that its effluent is crystal clear and stable for upwards of twenty-one days at all times. Moreover, the effluent contains less suspended solids and more oxygen than the waters of Irondequoit Creek into which it flows."

Street-Cleaning in St. Paul

Of St. Paul's 536 miles of streets, 391 miles are graded only, 32 miles are paved with macadam, 11 miles with gravel and 102 miles with durable pavement.

A little over half of the paved streets, or 58 miles, are cleaned by hand-sweeping under the patrol system, the force consisting of an inspector at $150 per month, an assistant inspector at $125 per month, from 106 to 125 sweepers and 10 shovellers at $3.50 per day, and 10 teams at $1.00 per hour. The average cost per thousand square yards patrolled last year was $54.50. Each man is assigned from 3,200 square yards in the business section to 17,000 square yards in the residential section. In the former section, paved alleys are swept once a week by a crew consisting of 4 men and a team. Rubbish receptacles at the street corners have their contents removed by a single team with two helpers. The balance of the paved area is kept clean by ward crews.

In addition to the sweeping, all paved streets are cleaned periodically with water, using Studebaker flushers and one auto flusher. In the retail district seven miles of streets or 146,400 square yards is flushed every night, while in the outlying districts flushing is done at intervals. The cost of flushing the downtown district was $34.61 per thousand square yards for last season, while the average cost per thousand square yards for one flushing of the outlying paved streets was 29.3c.

During the season 186 miles of streets were water sprinkled and 177 miles were treated with oil, there being used for this purpose 105 horse-drawn tank wagons, the teamsters receiving $200 per month, and four Kinney auto oilers. The cost of sprinkling and oiling is assessed against the abutting property, the aim being to charge the exact cost of the service. Last season the rate for sprinkling, four trips per day, was 9.8c per front foot; and the rate for oiling, two oilings per season, was 7.6c per front foot, the average width being 27 feet. The auto oiler distributed 625,500 gallons of road oil at a cost for oil of 7.4c per gallon and for spreading of $9.86 per thousand gallons.

Clay Pipe in Plumbing Systems

Two prizes, one of $100 and a second of $50, have been awarded for essays on the subject of "The Use of Vitrified Clay Pipe in Plumbing Systems." The contest was conducted by the Carnegie Institute of Technology and the prizes donated by the Eastern Clay Products Company. The first prize was awarded to William E. Morgan, of Salisbury, Maryland, a sophomore at Carnegie Institute, and the second prize to Thomas F. Moffett, of Saranac Lake, New York, for nine years a master plumber in the Bronx district of New York City. The judges were headed by Prof. S. E. Dibble, head of the Department of Plumbing, Heating and Ventilating in Carnegie Institute, while the other members of the jury were W. J. Woolley, secretary-manager of the National Trade Extension Bureau; Joseph A. Welden, master plumber of Pittsburgh, and John T. Morris, director of the College of Industry of Carnegie Institute.

Susquehanna River Power Dam

Perhaps the greatest single power development contemplated in the Middle Atlantic States at the present time is that planned by the Susquehanna Power Company, consisting of a hydro-electric plant on the Susquehanna river about half-way between Philadelphia and Baltimore. Five sites are being investigated, located between the head of tidewater and the town of Conoquingo, Maryland.

The plans call for the erection of a power plant with an ultimate capacity of 360,000 horsepower, created by a dam about 110 feet high. As required by the Federal Power Commission Act, application for permission to build the dam has been advertised. The company has obtained articles of incorporation from Maryland and has made application to the state of Pennsylvania. In the application the company states that the energy would be transmitted to places within a hundred miles radius to supply local demands. This radius includes Philadelphia, Baltimore, Washington, Wilmington and Trenton.

Construction of Connors Creek Sewer

By Carl Ashley

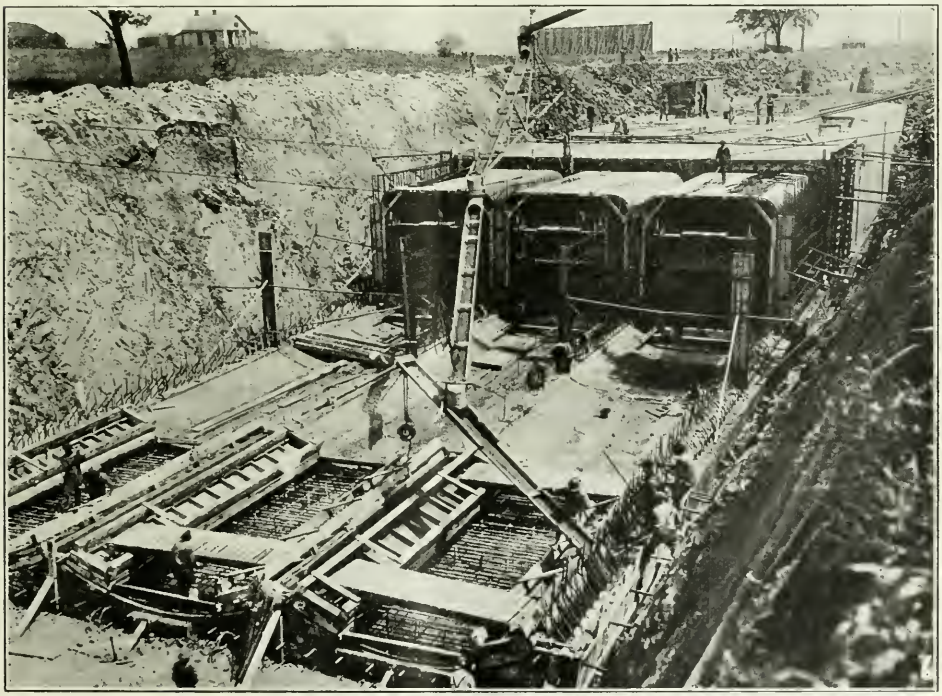
Construction methods on a triple sewer with a cross-section of 800 square feet, by means of which work was completed on the entire mile and a half in nineteen months, seven months before date set by contract.

On March 29th, 1921, bids were received for the construction of Section 1, Connors Creek Sewer, and on April 5th, 1921, the contract was awarded to the Gillespie Contracting Company of Detroit and New York. The date set for completion was June 1st, 1923, but the entire sewer was finished November 15th, 1922; in fact, with the exception of joining a short section under the tracks of the Detroit Terminal Railroad, all concreting was completed in September, 1922.

A general description of the sewer appeared in Public Works for March 11, 1922, and Detroit's sewer system has been extensively discussed in other engineering and contracting papers, but the contractors have been asked for an article and illustrations covering the work from a construction point of view.

The small map shows the location of the Lonyo Road and Connors Creek trunk sewers, which both follow natural drainage of existing streams. Connors Creek will be diverted from its natural channel and turned into the completed section before cold weather sets in. As the trunk sewer is completed northward, Connors Creek will be turned into each completed section. The length of Section 1 is 7,700 feet.

The entire Connors Creek system will drain



POURING CONCRETE. FINISHED INVERTS IN FOREGROUND. FINISHED SEWER IN BACKGROUND. FORMS SET AHEAD OF SEWER.

MAP SHOWING LOCATION OF CONNORS CREEK AND LONYO ROAD SEWERS.

forty-one square miles and is designed to care for a discharge of five thousand cubic feet per second when flowing full up to six inches below the roof. This discharge is not expected for many years to come, when the city has built up in the suburbs. The sewer will always be about seventy-five per cent. full in Section 1, due to the invert being about thirteen feet below the level of the Detroit river. The low-lying country through which Section 1 is built makes necessary the three large barrels, each 15′ 9″ wide by 17′ 6″ high, as shown in sectional view.

From the Detroit river north to midway between Jefferson and Kercheval avenues, the sewer is at present in open channel. Section 1 starts in the bed of Connors creek 600 ft. south of Kercheval avenue, follows the creek bed for 400 ft., passes under the tracks of the Detroit Terminal R. R., turns a right angle into Kercheval avenue, which it follows a short distance and then turns another right angle north into Connors avenue, in which the remainder of Section 1 is located—about 6,750 ft. Section 2, recently let, follows Connors avenue to Shoemaker avenue, a distance of 2,800 ft., where it enters upon city-owned land which will eventually be used for an outer park and drive. The total length of Connors creek sewer will be about seven miles.

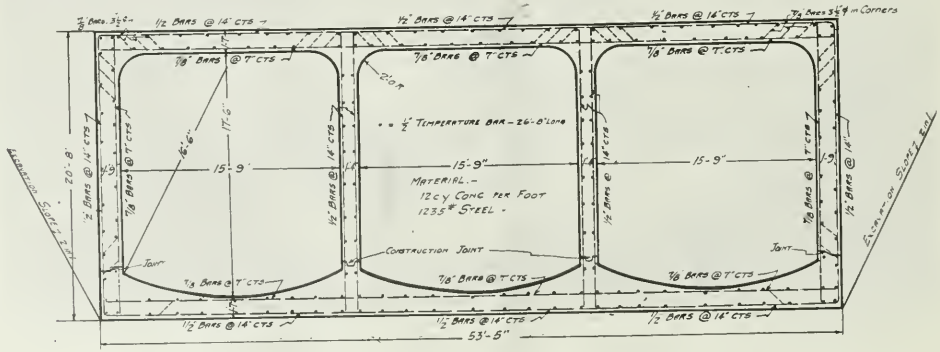
While the inside dimensions of the sewer are the same throughout, four various sections of reinforced concrete walls were built as follows, starting from the lower end of the work:

	Length	Concrete per ft.	Steel per ft.	Loading conditions
Sec. AA	350′	17 Yds.	2,930 lbs.	Steel billets in factory yard.
" A	282′	14 "	1,970 "	Det. Term. R. R.& fact'y coal yard.
" B	4,268′	11 "	1,130 "	Street fill, 1 ft. to 8 ft. deep.
" C	2,800′	12 "	1,235 "	Street fill, 8 ft. to 13 ft. deep.

The accompanying cross section shows the type of walls, roof and reinforcing steel used in Section C. All temperature steel was lapped 40 diameters at construction joints, so that the entire 7,700 ft. of sewer is practically a continuous structure. The cup bar of the Carnegie Steel Company was employed throughout. All bent bars were bent in the shops of the Concrete Steel Company, Youngstown, Ohio, forty per cent. of the total used being bent.

Active work was started early in May, 1921, on plant erection and laying construction tracks. The sketch and photograph show type of central proportioning plant for dry mix.

The cement house is 30 ft. x 130 ft., capacity 8,000 bbls., with gravel bin 21 ft. x 37 ft. at both ends. Each gravel bin has a capacity of 500 yards. The 36″ gauge track for concrete trains passes through the center as indicated on sketch. The location of the railroad tracks is such as to permit of unloading cement and gravel to the concrete trains or stocking it as the case may be. The capacity of the gravel bins is sufficient for a day's run in case of derrick failure. Steam pipes are installed in gravel bins for winter work. Maximum storage capacity is 9,000 cu. yds. One-yard Koppel cars were used in six-



CROSS-SECTION OF SEWERS, SECTION C.

car and nine-car trains to transport dry mix from the cental plant to concrete mixers. Fourton Burton gasoline locomotives and steam locomotives were used to haul concrete trains, average haul being one-third mile. The gas locomotives were employed in switching and charging the concrete trains and steam locomotives were used chiefly in hauling trains to the mixers. A daily average of 600 cu. yds. of concrete per day was maintained when both mixers worked.

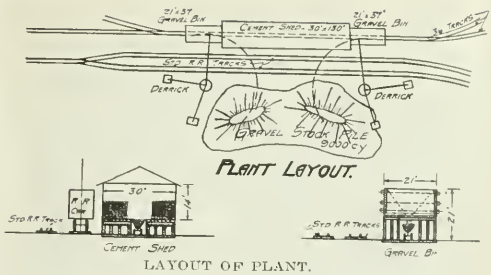
Two movable concrete mixing plants were installed upon bank of cut and moved forward on rollers of greased rails as the work progressed. The platform was 18 ft. x 30 ft. equipped with one-yard Lakewood Standard mixer, 45 ft. spouting tower, 30 h. p. boiler and concrete hoisting engine. From the tower hopper the concrete was distributed by a 50 ft. counterweight swinging chute. The sewer was built in two operations, the invert being kept about 100 ft. in advance of the completed arch as shown in photograph. All concrete equipment was of Lakewood make.

Collapsible telescopic steel forms from the Blaw-Knox Co. were employed on the straight portion of the sewer in Connors avenue. In 1921 a twenty-foot form was used, but during the winter of 1921-22 the forms were all lengthened to twenty-five feet in order to increase daily output. Four sets of forms were used in each barrel.

For winter concreting the outside steel forms were equipped with steam pipes covered with wood, the exposed roof being covered and live steam played over the concrete. The inside of the sewer chambers was heated by salamanders. Twenty feet per day was built up to December 21st last year and no signs of freezing were ever encountered, although the concrete was typically a reinforced structure with thin walls exposed to the cold.

The first right angle curve at Kercheval avenue was constructed with built up wood forms, knocked down and rebuilt entirely. The second right angle curve had only one permanent collapsible wood form with curved walers to fit the walls. This form was pulled along as work advanced.

The excavation, as is usual in sewer work, presented the great difficulty. The sewer structure is 54 ft. wide at bottom of cut, which averages 28 ft. deep with top width of 82 ft. As the city allowed merely the street as right of way—viz.: 60 ft., the contractor was obliged to rent lands on each side for his dump tracks and concrete mixing plants. From the Detroit Terminal railroad tracks north for 2,400 ft. all excavation was made by a No. 20 Bucyrus dragline using Page bucket. The excavated material was loaded upon four-yard dump cars and either dumped in sewer



LAYOUT OF PLANT.

backfill or deposited in low-lying lands obtained by the contractor for that purpose. In Kercheval avenue, 80 ft. wide, the sewer passes alongside brick buildings, and 14" arch web Lackawanna steel piling was driven to support sides of cut. The dragline excavated as much as possible without endangering the banks, after which 18" I beam walers with 54 ft. latticed steel struts across cut were placed. The remainder of the excavation was removed by a two-yard Williams clamshell. The clay was too stiff for a clamshell and excavating Detroit clay by a clamshell is to be at all times avoided. A second set of walers and struts was always placed to prevent bending of sheeting and consequent cracking of walls.

In the upper 4,900 ft. of the section, the top 12 to 18 ft. was dug by a No. 70-C Bucyrus steam shovel, a No. 20 Bucyrus dragline following in the cut and finishing excavation to grade. As a rule the banks would stand at a slope of two on one. The upper portion of the cut was yellow clay which breaks up on digging and dumps readily from the cars, but the lower portion was of blue clay that is very stiff and dumps hard. In fact, the dumping of excavated material is the most difficult phase of the daily progress, when an average excavation of 3,000 yds. per day is the mark set.

The portion in Connors creek bed and under the railroad tracks was constructed by an independent operation, using one-yard Williams clamshell on either derrick or locomotive crane. Concrete was deposited by bucket and Koppel cars. The flow of Connors creek was by-passed around

CONCRETE TRAIN PASSING THROUGH CEMENT SHED AND GRAVEL BIN.

work in a wooden flume until about 250 ft. of sewer was completed, when the three barrels were bulkheaded off and creek admitted to sewer. At the present time the creek flows directly into sewer through openings in west wall. The sewer passes for about 200 ft. under tracks of the Detroit Terminal R. R., which had to be maintained in operation. Pile bents and wooden stringers were used to support the tracks.

The total excavation for entire sewer was 551,000 cu. yds.; 90,000 cu. yds. of 1:2:4 concrete were required, a combined aggregate of proper proportions being supplied from the Oxford plant of the Ward Sand & Gravel Company. Peerless Portland cement from Union City, Mich., was employed throughout. A total of 4,900 tons of reinforcing steel was placed. The layout work and inspection are performed by inspectors from the Department of Public Works, Joseph A. Martin, Commissioner.

On August 25th of this year bids were received for Section 2, Connors Creek sewer, 10,630 ft. long. Alternate plans were proposed for a five-centered 18′ 9″ x 25′ 8″ reinforced concrete arch, or a two-barrel section, each barrel 12′ 0″ wide x 17′ 6″ high. The T. A. Gillespie Company was low bidder on both types, bidding $100.50 per ft. for the arch and $113.30 per ft. for the two-barrel. After deliberation the city awarded the contract for the two-barrel type on September 19th, 1922. Work was started at once and is now under way. The grade of the two-barrel sewer is .15 ft. per 100 ft., while that of the sewer in Section No. 1 was .035 ft., which permits a reduction of almost fifty per cent. in cross-section area without loss in capacity.

Trench Excavating Machinery in Brockton

By Harold S. Crocker*

Even with the small amount of building during the war period, the Brockton Sewer Department failed to keep pace with the demand for sewer extension. The labor market was inadequate, and the only solution was machinery, even regardless of cost.

New layouts had demanded new main collectors in several localities, resulting in each case in fairly deep cuts.

In 1920, after careful investigation, it seemed wise to purchase a Parsons excavator, size 36, and a backfiller of the same make. The excavator will dig a trench to any desired depth up to 15 feet, and from 24 to 36 inches in width. The original costs of the machines were $10,350 and $2,500, respectively, unloaded at Brockton.

The excavator was received in July, and was on the work that year 772 hours, of which it was in actual operation 374. The crew consisted of three men, the operator and two laborers, whose duty it was to remove the rocks encountered, and with bars break down the banks of the trench in cases where necessary when pipe was to be laid that required a trench wider than thirty-six inches.

Overhead was figured as the depreciation on the machine at 20% annually, or 10% for that half year, which amounted to $1,035, and interest for the six months at 5% (the interest paid on bonds that year) which added $258.75. The new parts, practically all of which were buckets and teeth, with the labor thereon, amounted to $196.61. The direct labor, charged whether the machine operated or not, was $1,813.76; gas and oil cost $232.51. The total cost that year was $3,537.39, and the machine removed 4,291 cubic yards of material, making a cost per yard of $.823. The cuts varied in depth from six to fifteen feet and average about eight and one-half feet.

In 1921 the total overhead, including 20% depreciation, or $2,070.00, and 5% interest, or $517.50, together with cost of overhauling, amounted to $3,883.31, and the total cost of operation was $11,811.92. The machine was in actual operation only about one-half the time that labor was charged against it because of bad weather conditions, days when the bracers could not keep up with the speed of the machine, or the pipe-layers could not acquire a speed sufficient to maintain the pace of either, and where it was unwise to purchase more sheeting because of the high price of plank. It removed 11,402 cubic yards in an average cut of over ten feet, making the cost per yard $1.036.

The 1922 work was similar to that of 1921, and the cost was about the same.

The machine is now on its fourth season, and I am convinced that the depreciation figure is too large. From the present indication, it could well be halved.

All kinds of material are encountered in Brockton, and the excavator will remove anything but ledge. Stone up to the size of one's head can be removed without stopping the machine. Much larger ones are brought to the surface and there removed to the bank by hand. There is no question but that the machine will dig anywhere, and remove material much cheaper than it can be dug by hand. The lowest figure on any street to date has been in gravel, where few large stones were encountered, and an average cut of about seven feet. That job cost forty-two cents per yard. With the depreciation figure as low as I suggested it might well be, the cost would have been reduced ten cents.

The backfiller, with overhead figured by the same method and with a crew of three men for puddling and tamping beside the operator, has replaced material for twenty-three cents per cubic yard.

While these figures do not compare favorably with some that have been called to my attention, yet with the varied soil conditions and large quantity of stone and boulders found in the city

*City engineer, Brockton, Mass.

the results are very satisfactory, and the work is being done far cheaper than it could be accomplished by hand.

Water Consumption in Charleston

The report of the Water Department of Charleston, S. C., for the year 1922 states that the services were 100% metered throughout the year and that a comparison of the total water pumped to the city mains during the year, as measured by the master meter at the pumping station, and the sum of all the amounts registered by the service meters show 80.1% of the water accounted for. There was a general increase in the accounted-for water during the year, it having reached 86.5% in November and 86.6% in December.

The total amount of water consumed during the year was 2,237,620,000 gallons, of which 623,600,000 passed through domestic meters and 1,168,000,000 through industrial meters, leaving 446,020,000 as unaccounted for. Part of this was used at fires, but the greater part was probably leakage or under registration of consumers' meters. The total number of meters in use in December was 8,923 on domestic services and 171 on industrial.

In 1918, with 76% of the active services metered, the per cent of water accounted for was under 50. In 1919, with about 88% of the services metered, the amount accounted for was about 70%.

Sewer Trenching by Dragline

A sewage disposal plant is being constructed for the Borough of Queens, New York City—one of several which the city is constructing at different points along its waterfront—the essential part of which is a 14-foot Riensch Wurl screen. To lead the sewage to this screen there is being constructed 1,100 feet of reinforced concrete sanitary sewer 9 feet in diameter, and 1,250 feet of reinforced concrete storm water sewer, 14 feet by 8 feet. These two sewers are located side by side in a single trench, with a space of 3 feet 8 inches between them, thus requiring a trench about 35 feet wide, allowance being made for sheeting and bracing. This trench has an average depth of about 26 feet, but reaches a maximum depth of 38 feet. The material excavated is a sandy clay on top, with fine, hard sand below. The bottom of the trench reaches from 5 to 7 feet below high water. The contract for constructing the sewers was let to Booth & Flynn, Ltd., for whom M. L. Quinn is acting as general superintendent.

The sewers pass through an undeveloped section, the street in which they are laid out not yet having been opened, so that there is ample room for casting the excavated material along one side of the trench. For excavating, the contractors decided to use a dragline, an Osgood ¾-yard being used, operated by steam power and equipped with a 45-foot boom and a Page dragline bucket. The dragline travels on the surface within and near one side of the line of the trench and drags the excavation in a circular fashion with and across the cut. The bucket discharges its load into motor trucks, loads between trucks being cast on the opposite bank well back from the cut. One bank is thus kept clear for the passage of the trucks and also of a traveling derrick which is used in excavating the bottom half of the trench.

The dragline is used to a depth of from 13 to 21 feet, depending on the stiffness of the soil, before the trench is sheeted, the banks being sloped slightly, giving the trench a width of about 40 feet at the top. It is not generally practicable to use a dragline in a trench with sheeting and bracing, although in this work it has been used to some extent in the sheeted sections, working between the bracing. The average progress has been about 350 yards during an 8-hour day.

Following the opening of the top half of the trench with the dragline, the bottom half is sheeted and excavated by means of a traveling derrick in the more usual manner. In constructing the sewers, Blaw-Knox steel forms are used and a traveling mixer plant located on the top of the trench. The spoil bank left by the dragline is used for backfilling.

The work is under the direction of Frank Perrine, engineer of sewers for the Borough of Queens.

DIGGING SEWER IN QUEENS BOROUGH WITH A DRAGLINE.

Segment Block Sewer Loaded to Destruction

By Henry A. Pulliam*

Test of an eight-foot section of sixty-inch sewer, to determine its acceptability by the cities of Paducah and St. Louis, made by city official.

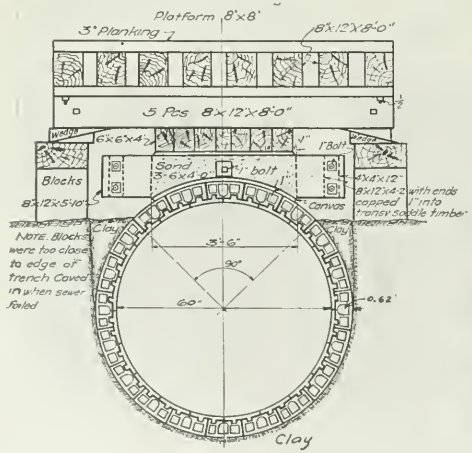
A new design of vitrified clay segment-block sewer, made by the LaClede-Christy Clay Products Co., was adopted for a part of the $1,500,000 sewerage program in Paducah, Kentucky, the adoption being subject to load tests that would determine its structural strength.

One of the tests of this block was completed May 25, 1923, in St. Louis, supervised by Guy Brown.† The results of this test were furthermore to be used in determining the acceptability of the block by the city of St. Louis. A sixty-inch sewer was built in the yards of the municipal asphalt plant and loaded to destruction. The breaking load was 137,007 pounds. The length of the test section of the sewer was 8 feet, the bearing surface of the pressure saddle being merely on the middle four feet. The width of the bearing surface was 3½ feet, confining the pressure to 14 square feet on top of the sewer, measured horizontally.

The Foundation—The earth on which the sewer rested was a soft clay, of a sort approximating the average construction conditions of that locality. The bottom was shaped in a circular manner to exactly fit the sewer, a procedure which is to be sought in the actual construction of this type of sewer.

*Commissioner of Public Works and City Engineer of Paducah, Ky.

†Principal Assistant Engineer of Sewer Design of St. Louis.



SADDLE USED FOR LOAD TEST ON 60-INCH SEWER

Backfilling the trench was carried to the elevation of the points on the extrados halfway between the spring line and the crown. Clay derived from the excavation was used for the backfill, well compacted by tamping.

The Loading Saddle—After allowing the mortar joints 28 days to set, a cradle was built as shown in the drawing. The timbers are heavier than required for the loading, an excess quantity of heavy pieces being left over from previous work.

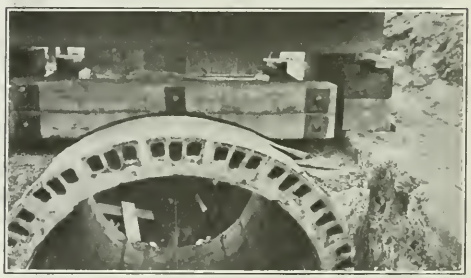
The sand cushion was entirely confined in canvas. The timber of the box which confines the sand at the sides and ends of the cushion was supported 1 inch above the sewer at the beginning of the test. After 10,000 pounds of pig iron had been loaded on the platform the pressure in the sand cushion maintained sufficient side friction to carry the box, and the box supports were removed. This left the entire weight, including box, sand, platform and pig iron, to be transmitted to the sewer through the sand cushion, no other part of the saddle structure being in contact with the sewer.

The Loading—A gang of seventeen men could wheel the pigs from a nearby pile, weigh them, and pass them up at a rate of from 15,000 pounds per hour in the beginning to 11,000 pounds per hour in the higher parts of the test load.

Blocks were placed on the ground surface at each side of the sewer to support the platform load. Wedges on top of these blocks were loosened after each 5,000 pounds of iron had been loaded on the platform, and the entire weight of the test load allowed to rest on the sewer. Deflections were measured while the wedges were loose, then the wedges tightened for the placing of the next increment of the test load.

Deflection Measurements—The displacements of the crown of the sewer were measured by noting the decreasing distance between the intrados at each end of the sewer and a tightly drawn wire running through the sewer and anchored to the ground at each end. This method did not indicate the decrease in vertical diameter.

Several independent measurements of the vertical diameter were taken. They indicated that the decrease in vertical diameter amounted to about an average of 60 per cent. of the deflec-



END VIEW OF TEST SEWER, WITH SADDLE IN PLACE

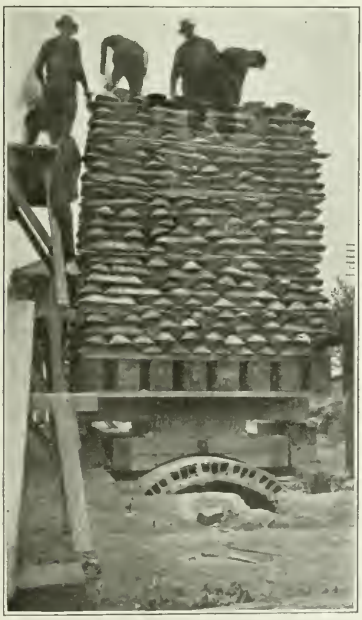
tion at the crown caused by the load, the remaining 40 per cent. being sinkage of the entire structure into the underlying clay. The crown displacements were read at first on an ordinary steel rule graduated to sixty-fourths of an inch, and later with a vernier caliper graduated to thousandths.

The increase in horizontal diameter was read with a rod and dial graduated to thousandths of an inch. All deflections were measured after each increment of 5,000 pounds in the loading.

Progress of Failure—The loading was started at 9 a. m. May 24, 1923. At 2.15 p. m. the first crack occurred at the intrados of the crown when the load amounted to 48,757 pounds and the deflection at both horizontal and vertical diameters amounted to about 3/64 of an inch. Cracks, in the extrados at mortar joints on both sides about half way between the spring line and the crown, developed under a load of 68,759 pounds.

At 128,976 pounds the crack in the intrados at the crown had opened to 3/32 inch in width, leaving the extrados edge of the block to carry the entire arch thrust. Under this load the webs of the blocks between the spring line blocks and the crown blocks sheared, closing the crack at the crown and distributing the thrust over the entire cross section at the crown.

Under 128,976 pounds the total elongation of the horizontal diameter amounted to 9/32 inch. The total sag at the crown under this load amounted to 3/8 inch, the initial measurement of the vertical diameter having been taken when the load amounted to 14,432 pounds.



LOAD ON SEWER SHORTLY BEFORE COLLAPSE.

The Collapse—When the load amounted to 128,976 pounds the sewer showed signs of distress and it was deemed too dangerous to continue the measurements. After one more increment of about 8,000 pounds the supporting wedges were again loosened at 2:30 p. m., May 25. Small pieces of mortar began to fall from the joints. Rapid cracking occurred. A few large pieces of the inner liner block dropped, and within 3 or 4 seconds the entire structure had collapsed. The laborer loosening the wedges had to exert himself to clear the pile, so quick was the failure. The point of initial rupture appeared to be on one side about half way between the spring line and the crown.

Summary of Test Load—The breaking load amounted to 9,800 pounds per square foot of sand cushion bearing. If, instead of being concentrated on the 14 square feet of sand cushion bearing, the load had been distributed over the entire top surface of the 8-foot test section of sewer from extrados to extrados at the spring line, the sewer could reasonably have been expected to carry a load much larger than 137,007 pounds.

However, calculating the total supporting power on a basis of 137,007 pounds over the projection of the entire top surface of 50 square feet gives a load of 2,740 pounds per square foot, which is more than sufficient for the most severe conditions in Paducah, where the maximum depth of 60-inch sewer will be 18 feet.

It might be added that the workmanship on the construction of the test section of sewer was better than the writer has ever seen under ordinary trench conditions, during a very limited experience with clay segment-block construction. Yet the test, in his opinion, was well balanced and entirely conclusive as to the strength of this sewer block.

Concrete Slabs for Bridge Floors

A bridge across the Connecticut river connecting South Hadley with Holyoke, Mass., showed maintenance charges for wooden floors so heavy that in 1922 the wood floor was replaced with one of concrete slabs, one-half the width of the roadway being left in service while the other half was being constructed.

The South Hadley end of the bridge consisted of two 160-foot spans. There was naturally a question as to whether these would be strong enough to hold the additional dead weight that a concrete floor would contribute, but investigation showed that the strength was there if the floor system were reinforced and additional floor beams put in so as to divide in half the original 16-foot floor beam spacing, the new beams being fastened by standard plate connections to hangers where the web members intersect midway between panel points. Stringers were placed on the floor beams 4 feet apart centers and these support the concrete slabs. The slabs were made 8 feet by 20 feet, weighing 8½ tons each, the longer dimension being placed across the roadway. In preparation for casting the slabs, careful measurements and levels of the floor system

were taken. The old floor beams extended above the tops of the stringers and the bridge is on a slight skew which rather complicated the construction. A plan of the floor system was made in duplicate at the yard where the slabs were cast, by means of steel shapes set in the same positions as the stringers and floor beams. Sand carefully levelled was used as the bottom of the mold and wooden arches were set on the sand to form arch recesses, the slabs being arched between points of support. Concrete was placed in the forms early in the fall of 1921 and the first slabs were not installed until the following May, so that there was ample time for curing of the concrete. A special frame was constructed on low, wide-tired wheels for carrying the 8½-ton slabs from the casting yard to the bridge, which frame was attached as a trailer to a 5-ton truck, which was assisted when necessary by a 10-ton Holt caterpillar tractor.

American Water Works Association Convention

Report of the forty-third annual convention, concluded from the June issue.

SUPERINTENDENTS' MEETINGS

The superintendents' meeting on Thursday afternoon opened with a discussion of Mr. Saville's paper on "Method of Paying for Waterworks Extensions." In discussing this, Mr. Saville called attention to the fact that overhead was included in the cost of the mains as assessed in Hartford and that this overhead averaged 23 per cent. of the total cost. A number of the members explained methods employed in their cities and states. It was reported that a law is proposed in the state of Iowa under which the property will pay for the extensions, the money to be refunded when the owner connects with the mains and begins paying water rates. A number of members reported slight variations on the guarantee system whereby owners of property guarantee the company or department a sufficient income from the property along the line of the extension to pay reasonable annual charges thereon.

A paper entitled, "Clogging of Intakes by Fish," written by Leonard Metcalf, was read by F. A. Marston. The incident narrated occurred at Portland, Maine, where Lake Sebago is used as the source of supply. From December 5th of last year to March 15th of this year fish were found to be very troublesome, collecting in great numbers on the screens. This became intensified just before storms, even during the winter when there was thick ice and snow on the lake. At such times it was necessary to keep men with fish nets baling the fish from in front of the screen all night and clean the screens frequently. Inquiry was made of piscatorial authorities and it was learned that the fish were American smelt or graybacks which presumably came up into Lake Sebago to spawn, it being the practice of this fish to run up from salt water into fresh and remain two or three days and then return to salt water, the spawning season being at about the time when these fish were troublesome. The author believed that where fish were abundant it was advisable, in order to prevent their being drawn into the screen, to maintain a velocity of approach at the screen of not to exceed 0.5 of a foot per second. Several members endeavored to match this fish story. New Bedford had had trouble with herrings, smelt and eels when using lifting screens but not so much trouble with the present revolving screens. Arthur V. Ruggles told of endeavoring to keep eels out of an intake by placing over the intake a box about 6 feet cube filled with rocks, but the eels came through the rocks into the intake.

W. C. Hawley explained that the title of his paper, "Averaging Bills," was really a localism for estimating consumers' bills when the meter fails to register. His practice in most cases was to base the bill upon past consumption, not of one month alone but over a series of months or years, and for this purpose he found the plotting of past consumption on cross-section paper most valuable both in making the estimate and in satisfying the consumer as to the justness of it.

The "questions" previously published were then taken up in order, the first being the advisability of using flush hydrants. Mr. Gwinn stated that he had sometime ago taken out a number that had been used in his city, and S. H. Taylor stated that the Fire Underwriters had penalized New Bedford for the flush hydrants which it had and they had all been removed.

The question was raised as to the advisability of laying 4-inch laterals in sparsely settled districts. Mr. Taylor told of one instance where a long line of 4-inch pipe and a 4-inch hydrant had been laid, and 250 pounds pressure before the hydrant was opened was reduced to 15 pounds at a 1⅛-inch nozzle at the end of a line of hose.

There was considerable discussion on the advisability of using 4-1/2-inch steamer connections on fire hydrants. Mr. Hawley questioned whether, with a fire pressure, say, of 125 pounds, a steamer connected to a 4-1/2-inch nozzle might not shake the hydrant off its connecting pipe. Pres. Cramer stated that where a steamer was connected to two 2-1/2-inch nozzles, this took more time than connecting to a 4-1/2-inch nozzle. N. M. R. Wilson said that large connections were entirely unnecessary, but that using a 4-1/2-inch suction hose with a 2-1/2x4-1/2 reducer connected to a 2-1/2-inch nozzle would give practically the same effect as connecting to a 4-1/2-inch nozzle, the smaller nozzle acting as the throat of a Venturi meter, and Mr. Brush coincided in this opinion. One member stated that the fire department in his city never uses the 4-1/2-inch connections, although the hydrants have them. J. W. McEvoy of Dubuque stated that in his city the 4-1/2-inch are used with all fires and give no trouble; and the same was reported by S. H. Taylor of New Bedford, Mass., and A. S. Holway of Oklahoma City, in which latter city there is a pressure of 125 pounds at the hydrant.

The question being raised why high pressure is necessary where steamers are used, G. E. Shoemaker of Waterloo, Iowa, stated that the fire chief of that city asks not to have the pressure raised during fires.

Concerning the question, "Who pays cost of meter repairs when damaged by hot water," Mr. Chester stated that the rules should require the consumer to pay. Frank A. Marston referred to a relief valve to prevent hot water backing into the meter, which valve is used as a hot water faucet and thus is prevented from corroding shut.

Discussing the question of the legal right to make more than one service charge on multi-family houses, Mr. Chester referred members to the New Jersey definition of "consumer," which had been commended by the Pennsylvania Public Service Commission and which answered the question. Mr. Holway recommended one service charge per meter.

In the evening Leonard A. Day presented the report of the committee on pumping station betterments and requested that oral and written discussions of the report be sent in to aid the committee in making next year's report. The report referred to the use of powdered coal, different types of boilers, etc. Mr. Day had tried pulverized fuel on a small scale and the results were not favorable, although they might be on a large scale. Another point discussed was the use of superheated steam for both reciprocating and turbine pumps.

William W. Brush, by means of slides and discussion of them, described the methods and records of water waste control in New York. Mr. Bolman said that in

Milwaukee curb cocks set by plumbers were found to be so poor and so many of them leaking that the furnishing and laying of them was taken over by the water department. E. S. Cole recommended separating the meter consumption of manufacturing plants and other large consumers from the total consumption, since the most variation was found in the former; which would leave the domestic consumption more nearly comparable, even when still coupled with unaccounted-for losses. Mr. Saville stated that tests made in Hartford showed 1-inch meters to be as accurate as 5/8-inch meters on all flows, contrary to common opinion. John Chambers of Louisville reported that an investigation of their distribution system showed only one joint leak of importance, but an enormous waste.

Mr. Brush requested all members who had figures on the subject to send to the committee records of night consumption and how much of this was manufacturing, day consumption, and a description of leak investigations made, with the results and what the investigation had cost. Concerning stopping leaks, he stated that additional water from the Croton supply cost New York 25c per million gallons, while the stopping of leaks in the distribution system during the past few years had averaged $3 per million gallons of leakage thus eliminated; and that therefore until additional water cost much more than at present it did not pay to stop underground leaks in New York City. D. M. Hanna of Windsor, Ontario, had used an electric leak locater with success, but found that it could not be used where there was any noise, even that of a rainstorm, and it therefore would not seem to be applicable to noisy city streets.

G. Gale Dixon presented the report of the committee on Physical Standards for Distribution Systems, of which there was no discussion.

J. M. Diven presented the report of the committee on Standardization of Services, in which he discussed the new prepared joints and threaded centrifugal pipe. The strength of lead pipe of different sizes and a more scientific adjustment of thickness to size and pressure was a subject that the committee is to investigate this year. Concerning the use of brass pipe, he stated that this was no more expensive than heavy lead pipe. The committee is now trying out copper pipe. Mr. Fuller reported that there has been renewal in England of interest in lead poisoning, although a greater or less number of cases seem to occur every year in that country, where there is a great deal of soft water.

The final report of the evening was that of the committee on Standard Specifications for Water Meters, C. M. Saville, chairman. This committee had co-operated with one of the New England Waterworks Association in preparing this joint report, which was published several weeks ago. The report was accepted and the committee continued and asked to give further study to the matter of registration.

FRIDAY SESSIONS

Friday morning's session of the superintendents' meeting was opened with a demonstration by Charles P. Hoover of the standard method of water softening, Mr. Hoover illustrating the chemical reactions by means of two large test tubes, one containing hard water and one with zero hardness, lime water and phenolphthalein. In discussing this subject it was stated that Newark, Ohio, has begun introducing carbon dioxide as a gas through filtros plates instead of in the ordinary manner. A similar process was just being started in Lansing, Michigan. At Flint, Michigan, it has been noticed that a flat taste followed the softening and a carbonator was installed for improving the taste. It was suggested by Mr. Hoover that the ideal process would be the collecting of the CO_2 gases given off in the burning of the lime and introducing these into the softened water to combine again with the lime, thus returning it to approximately its original chemical condition.

The use of a portable air compressor on a water works distribution system at Champaign, Illinois, was described by F. C. Amsbary, the manager of the water company. This was used chiefly for operating a tool for cutting out concrete and brick pavements in trenching for pipe lines and services. Before making the purchase, local contractors agreed to rent the machines, thus securing sufficient use to meet overhead costs. The compressor was mounted on a Ford truck. Shortly after receiving it it was used in cutting a narrow trench for a conduit. Contractors cutting a trench 121 feet long, along one side of the street, using hand labor, found the cost to be 27 cents a running foot, while a trench of the same length on the opposite side of the street was cut by means of the air compressor at a cost 9¼ cents per foot. Twenty-one lineal feet of hard concrete was cut out in 20 minutes by means of the compressor, while it would have required two men 2 hours by hand. The compressor cost $1,087, the truck cost $558, $44.50 was paid for freight, hauling, etc., and the total cost, ready for service, was $1,723. The compressor was also used for operating a tamper on backfilling, a pneumatic spade, and probably will be used for calking and other toots.

It was announced at this session that Prof. George C. Whipple had retired as a member of the Standardization Council and that his successor was W. W. De Berard.

Additional superintendents questions were taken up, the first being one asking for experiences with flush-flow water closets, especially the size of service pipe required and used. Two members reported using 5/8-inch service pipe, but placing in the basement a 40-gallon boiler which operated as an air-pressure tank, a larger pipe being carried from the bottom of this boiler to the flush valve. Provision was made for recharging air into the tank by drawing off the water by means of a stop cock, while air was admitted through another stop cock in the top of the tank. Mr. Hawley stated an instance where 20 closets in a school house using flush valves were fed from a 1-inch line by means of a tank such as this. Mr. Ackerman had used a 40-gallon hot water tank to cushion the hammer from hydraulic elevators and found that in this case the air in the tank was absorbed within 24 hours. C. R. McFarland suggested that added fire risk would be caused by the use of 1½-inch or 2-inch service pipes as compared to the customary 5/8-inch should they be broken off during a fire. A. S. Holway stated that in Oklahoma City consumers could have any size of service pipe they asked for, but a service charge was made, regulated by the size of pipe, and the same idea was expressed by Mr. Chester. As to the importance of the question to water works superintendents, a representative of a company manufacturing these valves, stated that 30% of the closet flushers installed last year used these flush valves. As an advantage offsetting the large size pipe, he stated that they used less water per flush than did the ordinary tank.

Concerning the question of keeping the records of the location of water services, Mr. Brush stated that in New York it is required that they be laid perpendicular to the street line and the location from the nearest street corner be determined and recorded to the nearest inch. J. E. Gibson stated that he had used an electric pipe locator very successfully for locating services.

Answering the question as to the control of lawn sprinklers used on a flat rate basis, Mr. Chester apparently expressed the sentiment of the convention that the only proper plan was by putting them on meter basis.

Concerning the laying of water mains or services in the same trench as sewer pipes, several members reported doing so under certain conditions and with precautions. Among these was Mr. Brush of New York; A. V. Ruggles of Cleveland, and others. Mr. Ruggles stated that they were not laid in the same trench unless this was in rock, when the water pipe was laid on a ledge cut into the side of the trench. Mr. Folwell had laid them in a deep rock sewer trench by building piers of lean concrete 12 feet apart against the side of the trench as supports immediately behind the bell of each pipe.

J. N. Chester then read a paper entitled "Leakage and Unaccounted for Water," in which he emphasized the

importance of locating leaks and reducing to a minimum the unaccounted for water, stating that leaks could ordinarily be located at comparatively small expense of money and time. He had found especially useful the pitometer and the geophone. By these means a leak had been located at Piedmont, West Virginia, in two nights and he believed that almost any leak, no matter how difficult its location, could be discovered in that time. As for unaccounted for water, records seem to indicate that under-registrations of service meters of 25% to 60% was by no means uncommon. Incidentally, he stated that, contrary to more or less popular belief, meters could over-register by reason of deposits formed on the inside of the chamber of the meter which would more than offset the slowing up of the operation of the meter because of these deposits. A. S. Holway told of 44% of unaccounted for water having been reduced to 26% by proper investigation, the loss having been due largely to under-registration of meters. Mr. Cramer spoke of one instance in which the water works authorities were sure that the distribution system was in perfect condition with no appreciable leakage, and yet investigation showed 740,000 gallons a day leaking into a sewer.

By means of lantern slides, Chetwood Smith showed startling results from the explosion of kitchen boilers due to failure to turn off the gas heaters connected thereto and the failure of relief valves to operate. These illustrations showed kitchens and adjoining rooms completely wrecked by such explosions. The only safeguard (where there are check-valves) would be some means of insuring that the relief valve operated occasionally so as to prevent the pipe clogging or the valve seat corroding in place, or else the use of a valve with a seat so large that moderate pressure would overcome such corrosion. E. T. Crane expressed the opinion of several of the members in stating that he believed it much better to omit the check-valve altogether, it being much preferable to pay for repairing an occasional meter burnt out by the backing up of hot water than to run the risk of such explosions.

Charles Fox of the Pennsylvania Water Company of Wilkensburg showed by slides the cards used in the meter card index system of that company, these forms having been in use since 1910.

The session concluded with a paper by J. Walter Ackerman entitled "The Effect of Industrial Use of Water on Total Consumption."

The afternoon and concluding session of the convention opened with a paper by Donald H. Maxwell, entitled "The Water Works Coal Pile." Messrs. Toyne, Bohman and Denman discussed this paper. A paper entitled, "A Possible Source of Income for Small Plants," by Howard Dili, was read by Mr. Gwinn. The final paper by John W. Toyne entitled "The Use of Fire Hydrants for Purposes Other Than for Extinguishing Fires," was followed by considerable discussion, largely as to the methods of preventing such use or rather misuse. A number of the members believed that while prevention was desirable, the most practicable result obtainable was a careful regulation of use by means of permits issued by the waterworks. Many of the members, however, cited instances in their own cities of unfortunate and sometimes disastrous results from the use of fire hydrants by contractors.

Following these papers a discussion of various subjects was carried on by the superintendents, these subjects including "Treatment with Copper Sulphate to Destroy Algae," Messrs. Fuller, Cramer, Chambers, Gibson, Crane, Milne and others discussing it.

A poll was taken to determine what states require a license for filter operators, and representatives from Pennsylvania, Iowa, Kentucky, Ohio and Virginia, as well as Canada, reported that no licenses were required in their states. While Ohio requires no license, it has a strong association of filter operators which meets once a year. New Jersey requires operators to have licenses. Texas also requires licenses and conducts a school for filter operators.

The subject of "Maintaining Water Services and Payment for the Same" was discussed by Messrs. Brockway, Bulkeley, Bunks, Chester, Cramer and Davis. The subject of "Private Fire Protection Services" was discussed by Messrs. Bohman, Chester, Gwinn and others; following which the convention adjourned.

Refuse Collection in Waltham

The collection of garbage in Waltham, Mass., was taken over by the city forces on the first of May, 1922, and the procedure followed is described as follows by George C. Brehm, Director of Public Works, in his annual report for that year:

"A central dumping platform was constructed of concrete at the water works yard. This dumping platform is built entirely of concrete and supplied with water and sewer connections. It is thoroughly washed at least twice a day.

"The city is divided into seven routes. Six routes are in the built-up section of the city and are handled by steel sanitary dump carts, which hold 54 cubic feet of garbage. A small truck with a steel, sanitary, 1-yard body is used in the outlying districts. These carts and trucks make two trips a day. The garbage is brought to the dumping platform and dumped through the scuttle hole into the trucks backed under the platform. As soon as the carts are emptied they are thoroughly washed and cleaned with a hose before leaving the yard for the second load. The routes are so laid out that two collections per week are made at each house. In the business sections a collection is made every day.

"The garbage collected is sold on bids and was this year awarded to Thomas F. Bergin at a contract price of $4,200 per annum, delivered into his trucks at our yard. The amount of garbage collected each month is given in the following table:"

May	625½	cord	feet
June	603	"	"
July	451	"	"
August	860½	"	"
September	621½	"	"
October	736	"	"
November	650	"	"
December	682	"	"
January, 1923	647	"	"

The dumping platform consisted of a concrete bridge or under-pass just high and wide enough to permit a truck to pass under it, with a ramp or inclined approach leading to each end.

During the year 24,388 cubic yards of ashes were collected using an autocar, 4 bottom-dump carts and 4 double sleds (the last for 22⅝ days only.) A Kelly-Springfield truck was used one day. The cost was $19,256, of which $12,847 was for labor, $5,465 was for teams and trucks, the balance for equipment repairs, new equipment and vacations.

Titles for Automobiles in Pennsylvania

A law just signed by the governor of Pennsylvania makes it illegal to own or operate a car in that state after November 25, 1923, without a certificate of title, and no 1924 license tags can be obtained without such certificate. Certificate of title is good for the life of the car.

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A. PRESCOTT FOLWELL, Editor

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Economy of Trenching Machinery

Of all the cities, large and small, replying to the questionnaire sent out by us last month, about one-third report the use of excavating machinery in sewer trenching. As a number of the cities laid only a few hundred feet of sewer, for which the use of a machine would not be economical, it appears that trenching machinery was used on fully a half of those having any amount of sewer on hand. Information concerning the use of such appliances in several cities will be found on pages 222, 223 and 236 of this issue.

One of the engineers who gave some details concerning operation states that his excavator does the work of 30 to 40 pick-and-shovel men, where the conditions are ideal. In another city, where large stones and ledge rock were encountered and other conditions were far from favorable, the showing is not nearly so good, but even here the city engineer reports that "the work is being done far cheaper than it could be accomplished by hand."

Taking the first case, and assuming labor at $4 a day, excavator operator at $8, gas and oil at $5 a day, maintenance and repairs of machine at $1,000 a year, machine operated 150 days a year but crew on the job and paid for 200 days, and depreciation at 15% and interest at 5% on a cost of $12,000; we have the cost for 150 days' work as $7,350 by machine; while 30 men would cost $18,000, and 40 men $24,000, showing a profit of $10,650 to $16,650 a year under ideal conditions.

It must not be overlooked, however, that there are some conditions under which the use of a machine would be uneconomical; (although there are other advantages of machine excavating, such as independence of labor and minimized blocking of streets, which may outweigh absence of economy). Numerous pipes crossing the trench, quicksand, boulders, or limited number of working days, may so cut down the amount of work done in a year that the fixed cost of $6,000 to $7,000 can not be met by the operating profits. But the advantages under most conditions are so great that the use of excavators should be considered where any but the smallest jobs are being figured on.

Salaries in Federal Scientific Positions

Elsewhere in this issue we give notice of Civil Service examinations to be held for a number of positions in the Federal service, to be filled by engineers, physicists or others with scientific training. We would call especial attention to the salaries offered. Take, for instance, that of Junior Aid, Grade One. To fill this position the applicant must have graduated from a four-year high-school course, which included at least one year's work in physics, chemistry and manual training. This young man of eighteen or nineteen who has successfully completed the high-school course will be paid the enormous salary of $540 a year, plus an additional $240 a year generously granted by Congress to allow for the present high cost of living. The total will then amount to about $2.50 a day. Laborers are now receiving nearly double this amount and the basic wages for plasterers and others in the building trade are more than four times this.

Going up almost to the top of the list, we find that an engineer who has graduated in civil engineering from a school of recognized standing and has had additional training and experience may receive $1,740 a year, or about $5.60 a day, or about half the amount being paid to mechanics in the building trades.

When we take into consideration the cost of a four-year course in an engineering school, including the loss of wages meantime, and the greater respon-

sibility imposed upon an engineer, to say nothing of the other qualifications that are essential and which are generally considered entitled to higher pay than that of a mechanic, who carries out minor details under the orders of his superiors and in doing so utilizes a skill which can be acquired in comparatively few months, the discrepancy between the amounts paid to mechanics and those allowed by the Federal Government certainly cannot be considered as encouraging men possessing any ambition to enter the technical departments of our Government.

Advice by State Engineers

A paragraph in the report for 1922 of the Maryland Bureau of Sanitary Engineering reminds us of the discussion recently held by members of the American Association of Engineers and others concerning the giving of engineering advice and services by men in the employ of state or federal governments.

This paragraph is as follows: "The engineering services of the Bureau are available to all state institutions on work similar to the above" (advice, preparing plans and specifications, and supervising construction of sewerage and sewage treatment systems) "upon authorization of the governor or the legislature. As no appropriation is available for these added duties, it has been the policy of the Bureau to charge for the preparation of contracts, plans and specifications to the extent of the actual cost for the time and expenses of the men employed on the work, plus 15% of the amount of personal services of the men engaged, to cover use of equipment, blueprinting, stenographic services and engineering supplies. It is believed from past experience that this work can be carried on with less cost to the state if all improvements of a sanitary nature are developed under the supervision of the Bureau."

English Practice vs. American

Three items appearing in a recent issue of an English engineering paper would seem to warrant the opinion that England is considerably behind the United States in some respects. The contractor laying a large water main for the City of Manchester and employing a large force of men thereon has made no provision for housing these men, although the work is far removed from any city where they can find accommodations. As a result of this, it is reported that the men are sleeping at night in the water pipes and, in response to a protest, the contractors have agreed to contribute $700 towards the cost of converting an old factory into sleeping quarters for the men. The periodical refers in this connection to "the foresight shown by American engineers and contractors in providing temporary housing accommodation for workmen engaged on large contracts far removed from a town or city."

The second item refers to the fact that the police of the city of London have recently been supplied with dry battery lamps for use at night to take the place of bullseye lanterns burning oil which they have used heretofore. As the periodical states: "Certainly it is cleaner and should prove more economical." We would think it would also be much more convenient than the carrying of an oil lantern on night duty.

The third item refers to the numbering of houses, and in this connection says that in America "an entirely new method has been introduced, which consists in placing the number on the side of the curb immediately opposite the house. . . . There are two questions which one would like answered, namely: What is done in wet weather when the curbs are freely spattered by mud and the numbers hidden? and, How are the numbers distinguished at night?" In answer we would inform the English municipal officials that it is not the practice in this country to allow the streets to get so dirty that the curbs are coated with mud splashed from the gutters; and as for seeing the numbers at night, the answer is probably that the American streets are much better lighted than those of English communities. Incidentally we might state that the method is by no means an entirely new one, but was described in this journal about ten years ago and possibly had been in more or less common practice in certain sections of the country for some years prior to that.

It is sometimes claimed that English municipal governments are much freer from graft than are American ones, if in fact graft in its extreme form can be found there at all. We find, however, in an English paper the statement that it is rumored that the "technical staff of a certain borough council not 100 miles from London have reduced the receipt of baksheesh to a fine going even to the extent of appointing an official receiver, who receives on behalf of his colleagues and periodically shares out." It is intimated that if the contractors do not contribute as liberally as desired, it will result in claims of bad workmanship or other unfavorable reports, or the boycott of appliances or materials involved.

United States Civil Service Examinations

Examinations for the following positions are announced by the U. S. Civil Service Commission. Full information and blanks may be obtained from the Commission at Washington, D. C., or at the postoffice or custom house in any city:

Irrigation engineer, $2,400 to $3,600 or over a year.

Civil engineer, $2,400 to $3,600 or over.

Assistant irrigation engineer, $1,600 to $2,280.

Assistant civil engineer, $1,500 to $2,280.

Design draftsman at the naval operating base in Hawaii, $6.80 a day and $8.80 a day. (Experience in designing steel, concrete, reinforced concrete and timber structures for buildings, wharves, etc., essential).

Junior engineer, junior physicist and junior technologist in the Bureau of Standards, $1,200 to $1,500 a year.

Laboratory assistant, senior grade, in Bureau of Standards, $1,200 to $1,380 a year.

Laboratory assistant, junior grade, in the Bureau of Standards, $1,000 a year.

Senior aid in Bureau of Standards, $900 a year.

Junior aid, grade one, Bureau of Standards, $540 a year.

Junior aid, grade two, Bureau of Standards, $720 to $840 a year.

In addition to the above salaries, an increase of $20 a month has been granted by Congress to all who receive a salary of $2,500 a year or less.

Bates Test Road

The following letter from Clifford Older, chief highway engineer of Illinois, was received several weeks ago, and was submitted to Mr. Brown for reply, as is our practice. This reply was in turn submitted to Mr. Older. Delay in publishing the letters has been due to the time consumed in this three-cornered correspondence.

May 10, 1923.

A. Prescott Folwell,
Editor, PUBLIC WORKS,
New York.

DEAR SIR:

I have read with interest and much surprise the article by Charles Carroll Brown in the April, 1923, issue of PUBLIC WORKS, and purporting to be a discussion of the tests made on the Bates experimental highway. This article contains gross misstatements concerning the drainage of certain portions of the Test Road. The following are quotations from this article:

"*Macadam Bases Under Brick.* The sections of brick pavements and one of asphaltic concrete on macadam base were located near a culvert under the road, where, on account of the lack of drainage of the road, the water gathered, and, as a consequence, these sections were for much of the time soaked with water." . . .

"That the forcing of the macadam into the subgrade, softened by water, was the cause of the rutting of the brick pavements on macadam base was also evident, without reference to thickness of base. The sections with 8" macadam base were farther down the slope toward the culvert than those with 4" base."

The fact of the matter is that there is not now, and never was, a culvert under the road within one-quarter of a mile of the brick section having an 8" macadam base. The nearest culvert in the Bates Road to this section is located 1,500 feet west of the west end of the section mentioned. Nor is the statement true that the sections with 8" macadam base were farther down the slope toward the culvert than those with 4" base. As a matter of fact the slope of this part of the road is toward the east, and the 4" macadam base sections are east of the 8" macadam base sections, the drainage being from a point several hundred feet west of the 8" macadam base sections, past this section, the 4" macadam base sections, and beyond the end of the road to a natural drainage channel 400 or 500 feet east of the beginning of the road.

I would like to call attention also to the following further quotations from the same article:

"The same would be true of the rigid or semi-rigid wearing surfaces on macadam bases. Such bases might themselves be expected to give way on so poor foundation as they had, emphasized as this was by the extra amount of water almost always present on the sections of the highway in which most of them were located." . . .

"The writer's observation showed the portion of the section most nearly out of water to be in fair condition for light traffic." . . .

"The lack of the same action in the macadam under the brick sections and the lower asphaltic concrete sections is definitely due to the backing up of the water on account of the total absence of drainage at that point." . . .

"The 8" basese were in the water and the brick pavements nearest out of the water were 3" blocks on 4" macadam base."

The author states that this last quotation applies to Sections 1 to 5 inclusive.

These last quoted statements are as misleading and as utterly unfounded as those relating to the nearness of a culvert to the macadam base brick sections. Throughout the entire test a ditch was maintained on each side of the road having uniform slopes to the outlet. The bottom of these ditches at the highest point was 30" below the crown of the finished pavement, and at no time since the road has been built has water stood or flowed in side ditches at an elevation greater than 18" below the crown of the finished pavement at any point; nor at any time has the water stood or flowed in the side ditches at an elevation as high as 18" below the crown of the finished roadway for more than a few hours at a time. The statement therefore that "the 8" bases were in the water" is absurd.

The first increment of truck traffic tests was started on March 30, 1922. On March 25 there was a rainfall of .17 of an inch, and the same amount on March 26. On March 27 soil samples were taken from underneath each test section of the entire road, and this was done every week thereafter. Those taken from underneath the brick section having the 8" macadam base showed a moisture content of 31% of the dry weight of the soil. Those taken from underneath the rigid pavement slabs on the same date ranged in moisture content from 31.7% to 36.5% of the dry weight of the soil. Approximately the same relative moisture content applied until the sampling from the subgrade under the brick-macadam base sections was abandoned because of the destruction of these sections. These figures indicate clearly that the moisture content of the subgrade soil was certainly not higher than that of other sections at the same time.

The accuracy of the remainder of the statements in Mr. Brown's article may properly be judged by these facts.

Very truly yours,

Clifford Older,
Chief Highway Engineer.

A. Prescott Folwell,
Editor, PUBLIC WORKS,
New York City.

DEAR SIR:

Thank you for sending me a copy of Mr. Older's letter.

To reverse the order of his comments: He does not grasp the point which I am trying to make regarding water in the foundation of a road.

It really makes an almost inappreciable difference whether the water in the ditch is 18 inches below the crown of the finished pavement (which is 5 inches below the bottom of the 8-inch macadam base) or 30 inches below if the water is standing in the ditch or the sub-soil. The water will rise by capillary action in the clay soil and gather at convenient places. Small excavations along the edge of slabs and small channels to drain them indicated, at the inspection made in October, 1922, that water had been found in sufficient quantities to be drained away at places at a higher elevation than the low ground, the description of which Mr. Older objects to.

Wet sub-soil is a serious detriment to pavements, and the emphasis by progressive engineers is now laid on getting rid of it. This may be difficult in Illinois, but there are not many miles where it is impossible. It is largely a question of expense. The cost of the Bates Experimental Road may be justified if the cost of building and maintaining roads of various kinds on such a foundation can be estimated. The cost of constructing and maintaining proper drainage can then be compared and the more economical course chosen. My only criticism of the Bates experiment is that it did not include some bases which have been recognized for several years as improvements over some of those used.

The thesis of my article in the April number was that the macadam or broken-stone base showed up better as a base for asphaltic concrete, brick, and concrete than the others used, all three wearing surfaces on comparatively light bases standing up in very satisfactory relation to the excessively heavy reinforced concrete sections. Explanation of the exceptions to this statement was attempted by calling attention to the fact that these weaker sections were in lower ground than the rest so that the full effect of the macadam base was not obtained.

The reason for the excellence of the broken-stone base was developed to be the greater size of the voids in the layer, which stopped capillary action and kept water away from the bottom of the wearing surface. This macadam

layer acts as a distributor of the pressure from the wearing surface, and, as indicated by the successful sections, increases the durability of those sections and their ability to carry heavy loads.

It is evident that if water is permitted to gather in this macadam base the effect of its open structure will be lost and that it will be pressed down into the clay or earth foundation, which would be softened by the same water. Hence the necessity for good drainage of the macadam base.

I beg your pardon and Mr. Older's for being so blind in working out the April article as to make it difficult to follow. When I read it in type it did not seem as clear as was hoped; perhaps because it was made as brief as possible and stated the facts. This thesis was worked out partially in the article on bituminous sections in PUBLIC WORKS for December, and possibly Mr. Older will be interested in reading that.

This is not the place to carry this argument into all its details, and so it is stopped here at the risk of again being misunderstood.

As to Mr. Older's questions of misleading statements:

I first visited the Bates Road about Christmas, 1920, when it was under construction, with Mr. Fleming of the Illinois Highway Department. I do not have the profile of the road at hand, but it is my recollection that a culvert was located in Section 5 or 6 which at that time had no outlet, as stated in articles in PUBLIC WORKS in February, 1921. It served simply to equalize the height of water in the ditches on the two sides of the road. Possibly this culvert has been closed. My notes of my visit in October, 1922, show the same low spot. If there were no outlet to water gathering in this low spot it is evident that water would rise in the ditches and even higher until it reached the level of some place through which it could overflow over the surface of the ground. On account of the low rate of absorption of water by the characteristic Illinois soil this water must evaporate before it disappears. Possibly some outlet for this low spot has been devised. It was not conspicuous enough for me to notice it on my last visit. The pavement sections in the vicinity gave clear indications of more trouble with water than others farther up. This is my justification for all the statements that Mr. Older classes as misleading. If the drainage of this low spot has been effected I shall be more than glad to modify the statements complained of as much as may be necessary. I hope to visit the road again after the test now in progress is completed, and shall pay special attention to this point.

As to Mr. Older's question of fact:

I have in hand Test Road Bulletin No. 1, dated April 10, 1922, which contains "Descriptive Data on Bates Experimental Road," prepared by Clifford Older, Chief Highway Engineer. In this I find "Detailed Description by Sections." Beginning at the east end the first five sections are of brick on macadam base and each 100 feet long. Sections 1, 2 and 3 are stated to have a base course thickness of 4 inches of crushed limestone, and Sections 4 and 5 have 8 inches base course thickness of crushed limestone. I do not find any other brick sections with macadam base.

Sections 23 to 39 have crushed limestone aggregate in the base, but this is definitely stated in the headings of the descriptions of these sections to be portland cement concrete base. Section 58 is of 4-inch portland cement concrete on 4-inch rolled stone base. This section stood better than heavier sections without rolled stone base, and was noted in my April article as one of the evidences in favor of the value of the macadam base. In one of the bulletins descriptive of the tests the good condition of this section was suspected to be on account of better drainage than that of other sections. My own comment in effect was that the macadam base is a better explanation (on account of the cutting off of capillary action) than luck in placing this particular section in a particularly dry 100 feet, not possible to select purposely except by detailed borings to determine water content of soil. Possibly Mr. Older has confused one of these sections — 23-39 or 58 — and called it 8-inch macadam. If he is right I shall be glad to have the number and full description of the section. At any rate I have no notes of such a section and no brick sections on macadam base except 1 to 5, which were referred to in my article. And the lowest spot is on Section 5 or 6, with the road sloping up to east and to west therefrom.

Yours very truly,

Charles C. Brown.

Los Angeles' Outfall Sewer

First steps being taken in the construction of twelve million dollar project. Novel features of design.

Bids were received on July 9th for four sections of a new outfall sewer for Los Angeles, California, known as the "North Outfall Sewer," and on July 30th bids will be received for the ocean end of the outfall at Hyperion. A bond issue of $12,000,000 has been authorized to pay for the outfall. The sewer is divided into fourteen sections, section 1 being the ocean end, with a length of 5,723 feet, most of it under water; sections 2 and 3 are the treatment plant, and the remaining eleven sections, totalling 81,377 feet, lead from the treatment plant to the city of Los Angeles proper. The sections being let this month include the submarine outfall at one end of the line and the four sections at the other end thereof.

The ocean end will consist of 429 12-foot lengths of pipe having an internal diameter of 84 inches and 46 12-foot lengths having an internal diameter of 60 inches. Alternate proposals are asked for Class D cast iron pipe of the standard bell and spigot type and for reinforced concrete pipe having special bell and spigot joints. The 84-inch pipe will extend 5,145 feet from the shore into 50 feet of water and here will divide into two 60-inch branches at right angles to each other and making 45 degrees with the main line, which will extend 283 feet further to a point where the depth is approximately 56 feet. At the outlet ends special fittings will be provided so that the sewage will discharge upward at a point about 4 feet above the ocean bottom. The pipe will be laid just below the ocean bottom which, according to the borings, consists almost entirely of sand. Piling will be required for a distance of 700 feet through the surf, and concrete aprons around each of the two special outlets. This contract will be for installation only, the city furnishing the pipe at the siding at Hyperion.

The submarine reinforced concrete pipe is to be composed of concrete mixed 1 cement, 1½ sand and 2½ crushed stone or gravel. The steel reinforcement will consist of two cages of 5/16 inches round wire; for 5-foot pipe one cage is 64 inches and the other 71⅜ inches diameter, and for the 7-foot pipe one is 89 inches and the other 86⅜ inches diameter. In addition to the circumferential reinforcement, there will be longitudinal reinforcement consisting of twelve ¾-inch bars placed just inside the outer cage and just outside the inner cage of the circumferential reinforcement. The pipes are to be made in 12-foot lengths with bell and spigot joints, allowing a ¾-inch annular space at the

joint, with a depth of bell of 7 inches for the 60-inch pipe and 8 inches for the 84-inch pipe. The concrete for the 60-inch pipe will be 8 inches thick and for the 84-inch 9 inches.

Section 11 consists of 5,130 feet of 7-foot 6-inch and 6-foot 3-inch sewer; section 12, 5,414 feet of 6-foot 3-inch and 5-foot 3-inch sewer; section 13, 9,802 feet of 4-foot 9-inch, 5-foot 3-inch and 6-foot 3-inch sewer; and section 14, 8,914 feet of 6-foot 3-inch sewer. Some of the other sections will be in tunnel, this including part of sections 4, 6 and 7, which tunnel is to be 13 feet by 12 feet.

In constructing the sewers, the city will use one of three types of construction, contractors being requested to bid upon all three. These types consist of: first, brick-concrete construction—a concrete invert with a brick arch and vitrified brick lining for the entire circumference; second, block construction, consisting of Ferguson segment block with a concrete base; third, pre-cast reinforced concrete pipe with vitrified clay lining, also resting on a concrete base. The city will furnish free of cost to the contractor, along the lines of work, all the brick, segment block and pre-cast concrete pipe required, separate contracts being made for the furnishing of these materials.

The pre-cast concrete pipe, from 4 feet 9 inches to 8 feet 6 inches internal diameter, is to be of concrete pipe reinforced with steel and lined with vitrified clay block integral with the concrete aggregate of the pipe. The concrete is to be mixed 1 cement, 2 sand and 4 crushed rock or screened gravel passing a 1½-inch screen. The clay lining blocks are of such widths that there will be 19 in the 57-inch pipe, 20 in the 60-inch, etc., up to 36 in 108-inch pipe. These blocks are 1 inch thick and 18 inches long, and at each side have a fan-shaped projection extending into the concrete and producing a dovetailed joint. The width between the vitrified clay lining blocks is not to exceed ¼-inch, except that the closing joint may equal ¾-inch, but all joints shall approximate ⅛-inch as nearly as practicable. The concrete pipe, including the blocks, varies in thickness from 5¾ inches for the 57-inch up to 10 inches for the 108-inch, increasing by increments of ¼-inch for each 3 inches in diameter. The reinforcement will be of spiral steel 5/16-inch, ⅜-inch and 7/16-inch in diameter according to the size, while the number of coils per linear foot vary from 3 to 5. The reinforcement is to be so placed in the concrete as to be ¾-inch from the clay lining blocks at the top and bottom and 1-inch from the outer surface on the horizontal diameter. This pipe, like the Ferguson segment block, is to rest in a cradle of 1:3:5 concrete 9 inches thick at the invert and with the distance between the outside vertical faces equal to the outside diameter of the sewer.

The brick-concrete sewer consists of a cradle with flat bottom and vertical outer faces, 2 feet 2 inches wider than the inside diameter of the sewer and extending up to the horizontal diameter thereof. On this is built an arch of common sewer brick, two bricks thick for 30 degrees above the horizontal diameter and one brick for the remaining distance; both arch and concrete cradle to be lined with a ring of vitrified sewer brick 3¾ inches thick.

The city asks for bids for 26,000,000 sewer brick and 16,000,000 vitrified brick for the construction of sewers of this type, should it be decided upon. For the arch brick a compression test is required of not less than 2,000 pounds per square inch, and for the interior lining brick an absorption limit of 4% of the dry weight of the brick when immersed in water for 24 hours.

Hill to Hill Bridge

Concrete arch highway structure, 6,000 feet long, 60 feet wide and 60 feet high, will afford a high-level connection between important business and residential sections of Bethlehem, Pennsylvania. It has several ramps, serving low-level streets and providing seven entrances. It will cost $2,568,000, and is now about three-quarters finished and will be completed in 1924.

By Frank W. Skinner

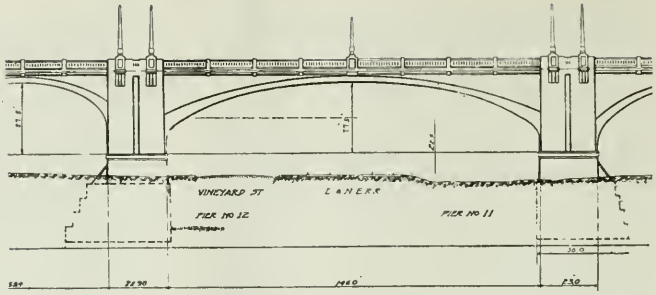
The construction of the hill-to-hill bridge in Bethlehem, Pa., over the Lehigh river, the Monocacy creek, several lines of railroad tracks, and a number of streets is a difficult engineering achievement of considerable commercial and industrial importance that has enlisted county, state, municipal and individual co-operation and will provide an unusually handsome and valuable improvement for the city and adjacent country. The problems occasioned by deep foundations encountering great quantities of water, and the simultaneous rapid construction of large masses of concrete in different positions and at different levels have been solved by the installation of $300,000 worth of construction equipment, which will mix and handle 100,000 yards of concrete, using about 160,000 barrels of Pennsylvania portland cement.

It connects the three principal, widely separated portions of the present city of Bethlehem with 70,000 inhabitants, providing easy and direct

communication, previously unavailable, between the original city of Bethlehem, South Bethlehem and West Bethlehem on opposite sides of the river and creek without ascending and descending steep grades, makes a common thoroughfare for the different sections, and provides convenient access to the principal railroad stations.

In response to a popular petition, the Bureau of Engineering of the Public Service Commission of the Commonwealth of Pennsylvania conferred, in 1915, with representatives of the citizens' committee and the council and with engineers of various interested railroads, after which the inadequate public bonds available were increased $1,119,899 by subscriptions from C. M. Schwab and other individuals and by contributions from the Bethlehem Steel Company, Northhampton County, Lehigh County, Lehigh Valley Transit Company, South Bethlehem Borough, Bethlehem Borough, and the Lehigh & New England, the Philadelphia & Reading, the Lehigh Valley and the Central Railroad companies.

The bridge is being built under the direction of the Public Service Commission, Dr. F. Herbert Snow, Chief of the Bureau of Engineering, acting through the local organization known as the Bethlehem Bridge Commission, of which Archibald Johnston is chairman and Clarence W. Hudson, engineer. The complete design of the structure was prepared in 1917-18, but the World War prevented its immediate execution. Bids for it were received in 1920, but, not being favorable, were rejected and a revised design was prepared in 1920-21, bids for which were opened June 30th, 1921, and the work was awarded to Rodgers & Hagerty, Inc., New York.

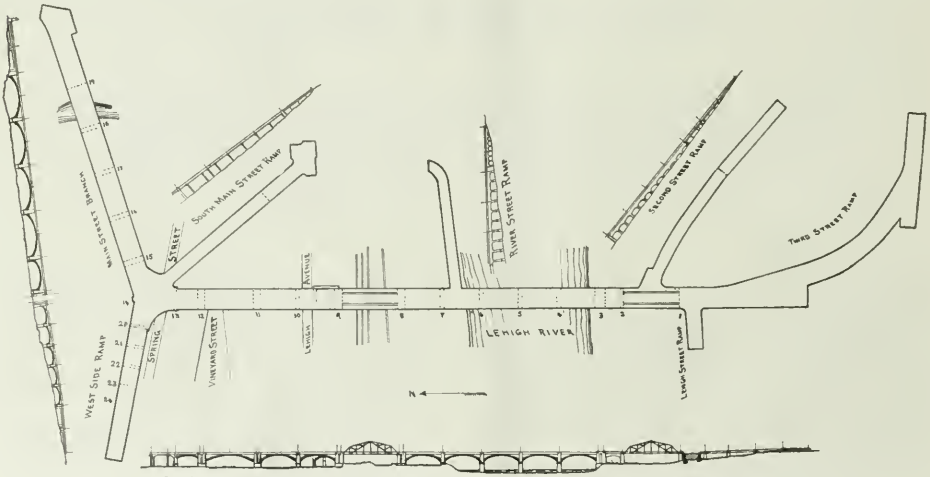


TYPICAL LONG SPAN OF MAIN BRIDGE.

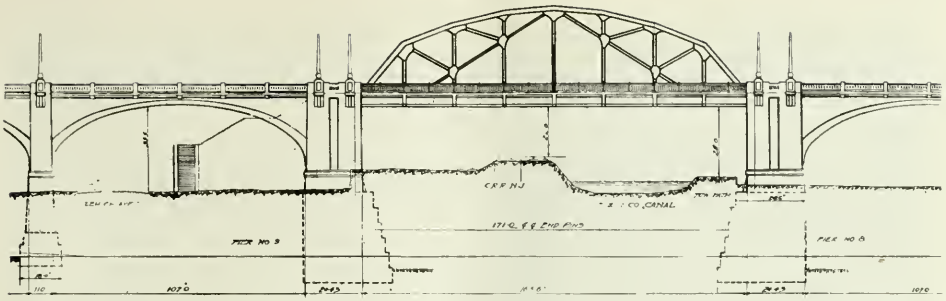
GENERAL DESCRIPTION

The main bridge, crossing the Lehigh river and valley, several railroad tracks, streets and a canal, is a tangent 2,085 feet long and 63 feet wide over all. Its roadway is carried at a level grade 57 feet above low-water level in the Lehigh river. It has ten main reinforced concrete arch spans and two steel truss spans, and is approached at both ends and on both sides by seven entrance ramps at various grades and chiefly of concrete girder construction.

Except for the long steel trusses, the main bridge has flat, barrel arches and solid spandrel walls continuous over the piers and surmounted by a molded cornice and a simple, heavy concrete balustrade carrying 100 obelisk-like, reinforced concrete electric poles on both sides of the roadway at piers and intermediate points. The piers are of two types, narrow and wide, according to the requirements of the arch spans, some of which give unbalanced thrust at the skewbacks. The intrados of the arch is continuous beyond the pier surface down to a projecting course that terminates the substructure several feet below the skewback. The upper part of the pier is a plain, tapered shaft that, in the wide piers alone,



PLANS AND ELEVATIONS OF MAIN BRIDGE AND APPROACH RAMPS.



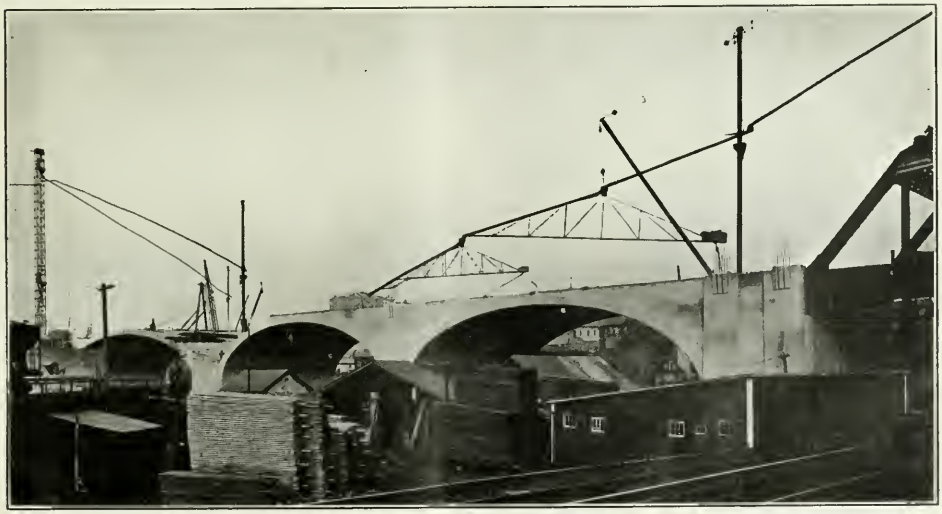
ONE OF DUPLICATE SPECIAL STEEL TRUSS SPANS FLANKED BY REGULAR ARCH SPANS.

is relieved by a narrow, center panel, above which two central panels are corbelled symmetrically to support the pair of electric poles; while on the narrow piers there is only a single corbelled panel and pole at each side of the roadway. Where some of the ramps intersect the main structure, the roadway platform is extended to eliminate sharp corners and the floor is supported on columns, girders, or piers, in some cases carrying groined arches that required complicated construction to secure a satisfactory and attractive appearance.

The granite pavement with concrete foundation is carried on a solid earth fill between the spandrel walls, which, with the arch, are waterproofed and are provided with a thorough drainage system. The main spans have a 44-foot roadway with two trolley tracks and two 7½-foot sidewalks with electric light and power ducts underneath, accessible through manholes. The side ramps have one 7½-foot sidewalk, one trolley line, one trolley track and one 36-foot roadway. The other ramps are narrower with single sidewalks and a minimum roadway of 21-foot width, the Second street ramps only carrying a trolley track.

The favorable positions of supports for the roadway of the South Main street ramp, which is 511 feet long and 38 feet wide in the clear, were so irregularly located that steel construction only was practicable, and a plate girder viaduct was adopted with a maximum girder length of about 100 feet. In general, the ramps are of reinforced concrete column and girder construction with spans of 15 to 30 feet. Beyond the abutment walls the pavement, with grades varying from 4% to a maximum of 8.9, is supported on solid earth fills between vertical retaining walls from 193 feet to 530 feet in length. The aggregate length of the ramps is 3,995 feet.

The bridge is designed for the heaviest city traffic and is proportioned to carry 24-ton motor trucks, and two continuous lines of trolley cars with loads of 30,000 pounds per axle, with additional impact allowance of about 50% of the live load and very conservative unit stresses.



TOWERS, MASTS AND CHUTES FOR SPOUTING CONCRETE TO MAIN SPANS, PIERS AND PORTIONS OF RAMPS.

ARCH SPANS AND PIERS

There are in the main structure eighteen reinforced concrete arch spans, including one with clear width of 147 feet for one span, 129 feet for four spans, 107 feet for five spans, 88 feet for one span, 65 feet for two spans, and 56 feet for five spans.

The requirements of a vertical clearance of 22 feet for a transverse width of 170 feet for the oblique intersection of the right-of-way for the railroad tracks passing under span 1-2 were too great for an arch span at this point, although it would have been more economical, and a special 171-foot through steel truss span was adopted, a duplicate to the span 8-9 over railroad tracks and the canal and towpath. A special type of truss, indicated in the elevation, was required for span 1-2 to permit it to receive, midway between piers, a wide roadway of the Second street ramp, clearance for traffic on which eliminated the possibility of diagonals in three panels of one truss, thus necessitating a design of floor suspended from pairs of inclined semi-trusses, that was worked out in extra heavy construction, made uniform for both steel spans.

All but one of the piers are carried down to foundation on limestone rock at an average depth of about 30 feet below water level, and have footings varying from 12 x 63 feet for Pier 13 to 55 x 60 feet for Pier 14. Pier 2 has little clearance between two tracks of the Lehigh Valley Railroad, and in order to avoid the excavation of a deep open pit so close to the tracks, the pier is supported on a foundation of 100 reinforced concrete piles, 32 feet long, driven in a clay and gravel stratum. For the west side ramp, the footings in clay gravel are proportioned for loads of four tons per square foot. The steel columns supporting the plate girders of the River street ramp carry comparatively light loads and are supported on wood piles driven in clay gravel and cut off below permanent water level.

The depth of the arch rings at the crown is 15 inches for the 56-foot span, 24 inches for the 65-foot and 107-foot spans, 27 inches for the 129-foot span and 30 inches for the 146-foot spans. Spans 2-3 have reinforced concrete girders, 48 feet long and 74 inches deep that are concaved slightly on the lower side to make it resemble the soffit of a flat arch. The tons of reinforcing steel and cubic yards of concrete, respectively, in the arch spans are, for the 107-foot, 65 and 690; 146-foot, 175 and 1,242; 65-foot, 45 and 418; 88-foot, 60 and 553; 129-foot, 110 and 83; 56-foot, 30 and 195.

The majority of the arch spans have elliptical intradoses, the dimensions of major and minor axes, respectively, varying from 56 to 129 feet and from 14 feet to 26.5 feet. Each semi-arch of the 56-foot span is made with construction joints dividing it into seven sections, three of which are key sections. The semi-arches of the 129-foot spans are similarly built in ten sections each, of which five are key sections. The skewback sections of each arch are built integral with the umbrella tops of the piers. These are heavily reinforced close to the intrados and extrados with longitudinal rods that are thoroughly spliced and extend into the pier masonry. In the 129-foot span, the rods 1¼ inches in diameter are 4 inches apart on centers and are supplemented by ⅝-inch transverse rods 12 inches apart.

The continuous spandrel walls have vertical tongue and groove expansion joints at maximum intervals of 25 feet and are thoroughly dowelled to the arch rings, near the inner and outer faces, with ½-inch round rods 3 feet long and 12 inches apart. The outer face is vertical and is not reinforced, while the inner face, battered 1:4, is reinforced with ½-inch rods parallel to the surface.

Concrete is proportioned 1 cement to 3 fine aggregate for exposed surfaces of sidewalks, curbs, gutters, fascia girders and protected steel work; 1:2:4 for beams, girders, slabs, columns, arch rings and skewbacks; 1:2½:5 for main piers, abutments above ground and spandrel walls, and 1:3:5 for foundations below ground and footings. The maximum size of aggregate is ¾-inch for floor slabs, railings and lamp-posts, 1-inch for arch rings and 2 inches for plain concrete. Cement was required to develop initial set in not less than 45 minutes and final set within 10 hours, with a tensile strength of 300 pounds per square inch for 28 day tests. Sand was required to pass through ¼-inch circular screen openings, and to be at least 70% retained by a sieve having 56 meshes per lineal inch.

The extradoses of the arches, the backs of spandrel walls and some other surfaces are waterproofed with three layers of asphaltic bitumen alternating with two layers of woven cotton fabric. The fabric has a tensile strength of 30 pounds per inch, a resistance to punching of 75 pounds per square inch, and is saturated under pressure with asphaltic bitumen.

Complete general plans were furnished by the Commission, but all of the detail plans, numbering over 300, were made, subject to the engineer's approval, by the contractor, who also made all surveys and was responsible for lines and levels.

Machines for Sewer Trenching

A number of city engineers who reported, in replying to our recent questionnaire, that mechanical appliances were used in their cities in trenching for sewers were requested by us to give such data as they had concerning this work, especially as to its effectiveness and cost. The majority of those who replied stated that they had no figures to give, in most cases because the work was done by contract and not by city forces. A typical reply from a New England city states: "We have made no tabulation or estimate of the saving effected by the use of this class of machinery or tools. We know, however, that there is a very great saving by the use of ditching machines, grab buckets, carons, etc., even though some of our machinery may be out of date."

Some of the engineers, however, were able to furnish more definite information. The most

complete received at the date of this writing is that furnished by Brockton and published on another page. The city engineer of Mansfield, Ohio, W. B. Statler, replies that they have used Keystone, Parsons, Austin and Buckeye ditching machines. The last named is used on light drainage work, the Keystone on trenches for storm sewers that are wide but not deep, while the Austin and Parsons are used on deeper cuts up to 19 feet.

In making cuts up to 9 feet depth under conditions suitable for their use, ditching machines have averaged the amount of work done by thirty laborers, while in cuts of greater depth machines have done the work of more laborers per unit of time, the number increasing with the depth. One report shows that on a sewer trench 18 feet deep and 1,000 feet long where the conditions for machine work were ideal, a Parsons machine did the work of forty laborers.

"In cases where there are many cross lines of sewer, water, gas and other pipes on the line of work, or where quicksand, water or rock are encountered, or if the cuts jump suddenly from a few feet to heavy cuts and back again so that the booms have to be changed very often, and if there are obstacles in the line of the work that will hinder the progress of the machine, hand work might be more economical."

In Beaumont, Texas, according to R. M. Fulweiler, city engineer, a contractor who has recently entered into a contract for laying 10-inch to 18-inch sewer from 10 to 20 feet deep is expecting to use a trenching machine on this work. Most of the trench, however, is shallow and the soil is a sandy clay which spades readily, and what records Mr. Fulweiler has show that this work is done about as economically by hand labor as it could be done by using a machine. This shallow work is generally done by city labor and costs from 15 to 30c. per foot for digging, laying and backfilling. Larger and deeper mains, however, have all been done by contract and the contractors have used trenching machines.

Electric Controllers for Sewage Pumps*

Description of design and operation of appliances for automatic operation of pumps for small electric sewage ejector stations.

In designing sewerage systems, the engineer often encounters low-lying areas of relatively small extent which can not be drained by gravity to the desired outlet or treatment plant. The only solution generally is to lift the sewage of such area into the gravity mains. Because of the relatively small amount of sewage to be pumped, a constant attendant involves prohibitive expense and an automatic plant is necessary. For this service electricity is most commonly employed. Such plants are now furnished which are certain in operation, and consume power only when and as required by the volume of flow.

The essential elements of an automatic electric sewage ejecting station are (1) the pumping equipment, (2) the electric motor for driving the pumps, (3) the control panel for starting and stopping the motor, and (4) the pilot device which governs the operation of the electric control panel. The last three of these elements constitute the electric controlling system of the station, and upon their functioning, the reliable operation of the station depends.

This controlling system will be of either the alternating or the direct-current type, depending upon the source of electrical service available. In small municipalities, or in those located in outlying districts, the alternating-current system is commonly employed, because of the many advantages in energy transmission obtained by its use. In such a case the municipality usually

*Furnished through the courtesy of the Electrical Industries Joint Committee for Business Development.

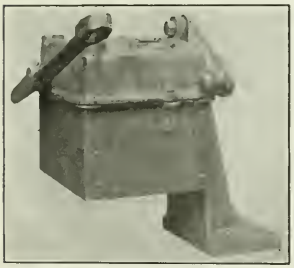


FIG. 1—ENCLOSED FLOAT SWITCH.

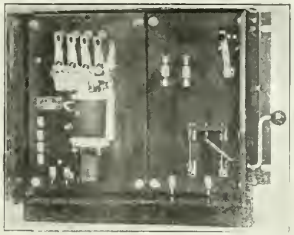


FIG. 2—AUTOMATIC STARTER; DIRECT CURRENT-RESISTANCE TYPE.

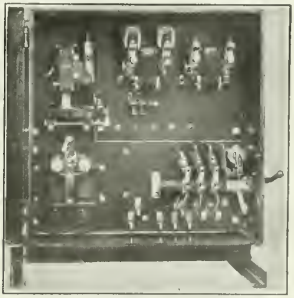


FIG. 3—PRIMARY RESISTANCE TYPE STARTER WITH CIRCUIT BREAKER.

FIG. 4—TRANSFORMER TYPE SELF-STARTER; 50 H.P. 230 VOLT.

receives its electrical energy from some distant power station, which supplies alternating current to a large area. Where the current available is direct, the electrical control equipment is designed accordingly.

The pilot device used to govern the operation of a control equipment is usually a float switch, such as is shown in Fig. 1. This is a rugged device which is used in the "pilot-circuit" of the control panel. This circuit is "made" when the sewage level is high, and "broken" at a low level. The switch is actuated by a rod on which is mounted a copper float. This rod is attached to the operating arm of the pilot switch, and the pilot circuit is made and broken with the corresponding rise and fall of the sewage level. It is customary to mount the float switch near the point where it is desired to control the sewage level. There are many other methods of mounting a float switch, such as an arrangement with a chain and counterweight, with stops to actuate the lever arm. The method used is, of course, governed by the particular installation. In some cases, the float switch is incorporated in the ejecting equipment itself.

A wire cage or screen is usually provided to keep the heavy sewage from interfering with the operation of the float. The same type of pilot device is used for either alternating current or direct current. The switch takes the place of an attendant, as it operates the controller only when needed. No attention is required, and current is used only when necessary, as the float switch operates the controller only during the time it is necessary to pump out the accumulated sewage.

The control panel, which is governed by the pilot switch, is used to accelerate automatically the driving motor, and to stop the motor when the "pilot circuit" is broken. It is an automatic device and takes care of all functions necessary in starting and stopping a motor. As mentioned previously, this panel will be of the alternating-current or direct-current type, depending upon the type of motor used. Sewage-ejecting motors range from 5 to 50 horse power in rating, depending upon the demands of the locality where they are used.

All direct-current motors require some sort of starting device to bring the motor from standstill to full running speed without damaging the motor or blowing the fuses. Such apparatus starts the motor with a series of resistance in circuit, and brings the motor to full speed by shunting one resistance after another until full supply voltage is impressed upon the motor terminals. The automatic control panel performs this function automatically, and it is much more efficient in operation than any manually operated equipment as it brings the motor up to speed in the minimum time without harm.

Methods of obtaining proper acceleration by means of automatic starters are of two general types, namely, time-limit and current-limit. With the time limit method, the motor is brought up to speed in the same period of time at each start. This period can, of course, be adjusted within given limits. A common type of time limit starter is shown in Fig. 2. The timing relay consists of three chief parts; an operating solenoid, a governing dashpot, and the contacts or fingers which are used to "cut out" the starting resistance. The plunger of the solenoid is retarded in its action by the dashpot, and when the solenoid circuit is "closed" the fingers are closed in succession. An adjusting screw is provided on the dashpot, (this may be of either the oil or air type) which allows for varying the time of acceleration. The resistance material is mounted in the rear of the panel. Above 25 horsepower, the timing relay is used to control a number of magnetic switches, and these switches function to cut out the starting resistance. It will be noted that it is usual to supply a "try-out" switch on the control panel, to allow starting the equipment direct from the panel. This switch is shown in the upper right-hand panel in Fig. 2. In this illustration are also shown a main-line knife switch and fuses, for the purpose of disconnecting the equipment entirely from the line. The fuses protect the motor from excessive overloads.

With current-limit acceleration, the current required by the motor is the governing factor used in starting the motor. If the motor load is light, the motor is accelerated rapidly; if the load is heavy, the equipment is accelerated slowly. In general, however, time-limit acceleration is much preferred because of its reliability of operation and wide range of adjustment.

On alternating-current equipments, where squirrel-cage motors are used, motors up to 7½ horsepower may generally be connected directly to the line. In such a case the control panel consists of a magnetically operated switch, which is used to "throw" the motor directly

"across-the-line" to start. When the motors are of a larger capacity, some means must be provided to reduce the starting current. This may be accomplished in several ways, the most common of which are (1) by inserting resistance between the mains and motor terminals as in the case of single-phase and squirrel cage induction motors; (2) by the use of starting transformers (in the case of large motors, or those operating on high voltage, such as 2,200 volts or over) for squirrel-cage motors; and (3) by inserting resistance in the rotor circuit of slip-ring induction motors.

In any of the above methods of starting alternating-current motors, the starting period may be governed by a timing relay, or by current relays. It is usual, as with direct-current, to use the timing method of acceleration, because of its reliability of operation.

A starting panel for starting a squirrel-cage motor by the primary resistance method is shown in Fig. 3. This equipment is provided with a timing relay for acceleration. It is used for starting single-phase commutator-type motors and polyphase squirrel-cage motors driving centrifugal pumps. One step is provided for starting, the starting resistor being cut out on the second step.

In Fig. 4, a polyphase motor starter of the transformer type is illustrated. Here, also, the starting period is governed by a timing relay. Such equipments are used on large squirrel-cage motors. For high-tension squirrel-cage motors, the magnetic contractors are immersed in oil. Slip-ring motors are used when a large starting torque is required. The starting resistor in this case is inserted in the rotor circuit. The motor is accelerated by cutting out this secondary resistor until the rotor starting resistance is directly "short-circuited," and the motor is up to speed. Here again, time-limit acceleration by dashpot control is usually employed. Where current limit acceleration is used, each secondary contactor is operated by its respective current relay, which functions when the rotor current is reduced to a predetermined adjustable value.

All automatic starters of the magnetic type that are governed by a float switch in the pilot circuit inherently provide low-voltage release; that is, the equipment will function as long as the full supply voltage is impressed across the actuating coils.

For sewage-ejecting installatjons, it is always advisable to use enclosed panel equipments, on account of the amount of moisture surrounding the installation.

Overload protection may be provided on these equipments. This feature protects the motor from overloads. Preferably, this protection should be of the inverse-time-limit type. This type functions rapidly to open the control circuit when severe overloads occur that would probably be injurious to the motor, but it allows a brief non-injurious overload to occur, without interrupting the operation of the equipment. The equipments shown in Figs. 3 and 4 are provided with this feature. Inverse-time-limit protection is usually supplied on alternating current starters, while for direct current installations fuses are used, except where the equipments are of large capacity.

Sewerage Statistics for 1922

Engineers of several hundred cities give figures and other data concerning the amount and kinds of sewers laid last year, methods of making joints, mechanical appliances used in trenching and backfilling and in cleaning sewers, construction of sewage treatment plants, and other features of sewerage construction and operation.

Our annual sewerage statistics this year, obtained through questionnaires sent out during June, give figures for the amounts of sewers built last year by several hundred cities, these being divided into vitrified clay and cement concrete pipes, of sizes less than 24 inches, from 24-inch to 36-inch inclusive, and larger than 36-inch; also other kinds of pipe sewers, and sewers built in place composed of brick, concrete and other materials. Also information is given concerning jointing materials used other than cement, and the use of labor-saving devices in trenching and backfilling and in cleaning sewers.

THICKNESS OF VITRIFIED PIPE

Of the three hundred cities whose replies to our questionnaire were received in time for inclusion in the tabulation in this issue, 243 reported laying vitrified clay pipe sewers in 1922. In reply to the question whether standard or double-strength pipe was used, 30 reported uring double-strength for all sizes, 2 used it for sizes larger than 24-in., 5 for sizes larger than 18-in., 4 for sizes larger than 15-in., 5 for sizes larger than 12-in., 3 for sizes larger than 10-in., and 4 for some sizes not specified. Standard only was used by 103 cities, while 87 did not reply to the question. It probably may be assumed that practically all of the last used standard only. Making this assumption, we find 78 per cent. using standard thickness only. Seventy-four cities laid pipe larger than 24-inch, and of these 40 used double-strength, or 54 per cent.

SIZES OF PIPE SEWERS

Of more than nine million feet of vitrified clay pipe sewer reported as laid last year, only three per cent. was larger than 18-inch, and only two cities laid any larger than 36-inch.

About 1,656,000 feet of cement concrete pipe was laid by these cities, of which 1,516,400 feet was less than 24-inch, 65,940 was 24- to 36-inch inclusive and 74,457 feet was larger than 36-inch.

A little over 6,000 feet was cast iron, and small amounts of some other materials were used.

OTHER SEWERS

Brick sewers are still being built; in fact, these cities reported considerably more brick than concrete built in place, or 705,550 ft. of the former and 407,510 ft. of the latter. The brick sewers ranged from 22x33 in. to 93-in., and the concrete from 30-in. to 135x204-in. Of the concrete sewers, those in 20 cities were reinforced, in 3 cities part were reinforced and in 13 cities they were not reinforced.

Vitrified clay segment block sewers totaled 135,088 ft. and ranged in size from 24-in. to 126-in., twenty-one cities reporting using this type of construction.

PIPE JOINTING MATERIALS

A very large percentage of the vitrified pipe sewers laid in the country are jointed with a mixture of sand and Portland cement placed by hand, but an increasing number of cities are using other materials and methods for jointing sewers, especially where there is danger of ground water seepage. From the replies to a questionnaire sent out in June, we find the following cities using joints other than the standard sand and cement:

What is known as the G. K. compound was used last year by Brocton, Mass., on 6,300 feet of sewer, or about 40% of all the pipe laid. Reading, Mass., used it for 300 feet, or about 40%; Watertown, Mass., for 3,733 feet, the entire year's work; Laconia, N. H., also for the entire year's work, or 2,175 feet. Other cities using it were Rahway, N. J.; Summit, N. J. (400 feet); Westfield, N. J.; Binghamton, N. Y. (7,715 feet); Elmira, N. Y. (13,929 feet); Lancaster, Ohio (1,300 feet); Allentown, Pa. (45,341 feet); Westerly, R. I. (all work), and Woonsocket, R. I. (6,849 feet).

Asphaltic and other bituminous material, trade name not given, was used by St. Petersburg, Fla. (9,500 feet); Hagerstown, Md. (74,215 feet); Newark, N. J. (179 feet); Plainfield, N. J. (6,910 feet); Johnson City, N. Y. (1,000 feet); Schenectady, N. Y. (all pipe sewer); Jamestown, N. D. (600 feet); Newcastle, Pa. (1,700 feet), and Watertown, S. D.

"Filtite" was used for 1,000 feet of sewer by Long Branch, N. J., and for the same length by Minot, N. D. "Jointite" was used for 3,000 feet in Joplin, Mo., and also by Rahway and Westfield, N. J. Sulphur and sand was used in all sanitary sewers by Newton, Mass. Oil City, Pa., packed puddled clay around cement joints of 2,642 feet of pipe.

In making cement joints, Weston's form was used for 600 feet of sewer in Hartford, Conn., and 6,200 feet in Adams, Mass.

Vitrified Clay Pipe Laid in 1922

City	Less than 24-inch	24 to 36-inch	Standard or double strength
Alabama:			
Dothan	7,600 ft.	2,000 ft.	Standard
Troy	2,100 ft.	.....	Standard
Arizona:			
Tucson	34,846 ft.	.....	.....
Arkansas:			
Pine Bluff	40,750 ft.	.....	Standard
California:			
Alameda	4,500 ft.	.....	Standard
Napa	400 ft.	.....	.....
Palo Alto	2,348 ft.	.....	.....
Pasadena	10 mi.	.....	.....
San Bernardino	12.2 mi.	.....	Standard
San Diego	240 mi.	.....	Standard
San Luis Obispo	12,000 ft.	.....	.....
Stockton	67,588 ft.	4.518 ft.	Standard
Colorado:			
Longmont	96,084 ft.	68 ft.	Standard
Connecticut:			
Bristol	1,400 ft.	.....	.....
Greenwich	340 ft.	.....	.....
Hartford	13,737 ft.	.....	Over 18" D. S.
Florida:			
St. Petersburg	9,500 ft.	.....	.....
Sanford	21,000 ft.	.....	Standard
Georgia:			
La Grange	78,600 ft.	.....	.....
Idaho:			
Nampa	2,000 ft.	.....	.....
Illinois:			
Beardstown	.....	10,000	D. S.
Benton	22 mi.	0.75 mi.	Standard
Canton	1,200 ft.	.....	.....
Centralia	3,000 ft.	2,200 ft.	Both
Johnson City	72,738 ft.	.....	.....
Kewanee	35 mi.	3 mi.	Standard
Mattoon	4,500 ft.	.....	Standard
Normal	1,823 ft.	.....	.....
Oak Park	1,418 ft.	.....	.....
Quincy	187,350 ft.	5,400	.....
Waukegan	10,426 ft.	.....	.....
Indiana:			
Elwood	800 ft.	.....	Standard
Fort Wayne	38,588 ft.	2,623 ft.	Standard
Gary	23,321 ft.	2,263 ft.	Over 15" D. S.
Huntington	3,000 ft.	.....	.....
Indianapolis	64,002 ft.	2,070 ft.	Over 18" D. S.
Iowa:			
Atlantic	360 ft.	.....	.....
Chariton	1,200 ft.	.....	Standard
Clinton	3 mi.	1 mi.	Standard
Creston	3,450 ft.	.....	.....
Davenport	10,518 ft.	5,896	Both
Mt. Pleasant	23,000 ft.	.....	Standard
Oelwein	13,000 ft.	.....	Standard
Red Oak	300 ft.	.....	.....
Kansas:			
Atchison	3,000 ft.	.....	.....
Dodge City	31,000ft.	.....	Standard
Emporia	29,600 ft.	.....	Standard
Independence	1,800 ft.	.....	Standard
Manhattan	500 ft.	2,400 ft.	.....
Topeka	19,823 ft.	2,655 ft.	Mostly stand'rd
Wichita	63,954 ft.	392 ft.	Over 12" D. S.
Kentucky:			
Ashland	3,744 ft.	.....	Standard
Louisville	5 mi.	2,000 ft.	Standard
Madisonville	39,000 ft.	.....	Standard
Paducah	.....	9,500 ft.	D. S.
Louisiana:			
Lafayette	5,995 ft.	775 ft.	Standard
Lake Charles	3,100 ft.	.....	.....
Maine:			
Augusta	3,200 ft.	.....	Standard
Portland	11,113 ft.	2,670 ft.	Over 12" D. S.
Rockland	1,644 ft.	.....	Standard
Maryland:			
Hagerstown	73,800 ft.	415 ft.	D. S.
Salisbury	800 ft.	.....	Standard
Massachusetts:			
Adams	6,200 ft.	.....	Standard
Andover	8,000 ft.	.....	.....
Brockton	15,703 ft.	.....	.....
Cambridge	5,531 ft.	.....	.....
Fitchburg	9,931 ft.	376 ft.	Over 15" D. S.
Lowell	9,618 ft.	.....	Over 10" D. S.
Medford	7,773 ft.	.....	.....

Vitrified Clay Pipe Laid in 1922—(Cont.)

City	Less than 24-inch	24 to 36-inch	Standard or double strength
Massachusetts (Continued)			
Natick	1,300 ft.	.....	Standard
Newton	20,434 ft.	2,326 ft.	Over 12" D. S.
North Adams	4,382 ft.	20 ft.	Standard
Peabody	263 ft.	.....	Standard
Reading	800 ft.	.....	Standard
Taunton	4,134 ft.	.....	D. S.
Waltham	4,060 ft.	.....	Standard
Watertown	3,733 ft.	.....	Standard
Worcester	15,393 ft.	8,303 ft.	Over 18" D. S.
Michigan:			
Battle Creek	15,470 ft.	138 ft.	D. S.
Dowagiac	4,435 ft.	.....	Standard
Flint	37,991 ft.	.....	Over 12" D. S.
Hastings	1,200 ft.	.....	Standard
Kalamazoo	144,884 ft.	14,852 ft.	D. S.
Ludington	1,500 ft.	.....	Standard
Marquette	1,620 ft.	.....	.....
Niles	10,000 ft.	.....	Standard
Minnesota:			
Austin	5,500 ft.	10,345 ft.	D. S.[a]
Bemidji	2,175 ft.	.....	Standard
Brainerd	5,035 ft.	.....	.....
Cloquet	3,251 ft.	.....	.....
Faribault	7,604 ft.	42 ft.	Standard
Hibbing	6,800 ft.	.....	.....
Little Falls	2,000 ft.	.....	.....
Minneapolis	59,000 ft.	3,763 ft.	D. S.
New Ulm	6,665 ft.	860 ft.	D. S.
Owatonna	2,800 ft.	.....	.....
St. Cloud	5,400 ft.	.....	.....
Stillwater	17,377 ft.	2,680 ft.	Over 12" D. S.
Willmar	12,000 ft.	.....	Standard
Mississippi:			
Clarksdale	3,000 ft.	200 ft.	Standard
Hattiesburg	5,170 ft.	.....	.....
Missouri:			
Carthage	17,520 ft.	.....	Standard
Fulton	500 ft.	.....	Standard
Jefferson City	908 ft.	.....	.....
Kansas City	47,240 ft.	10,560 ft.	D. S.
Maplewood	6,782 ft.	.....	D. S.
St. Louis	15,568 ft.	1,378 ft.	D. S.
Montana:			
Billings	6,970 ft.	.....	Standard
Bozeman	2,328 ft.	.....	Standard
Great Falls	5,247 ft.	.....	.....
Kalispell	2,600 ft.	.....	D. S.
Livingston	400 ft.	.....	Standard
Nebraska:			
Fairbury	800 ft.	.....	D. S.
Kearney	12,881 ft.	.....	Standard
Lincoln	42,468 ft.	121 ft.	.....
North Platte	1,200 ft.	.....	Standard
Omaha	132,600 ft.	7,100 ft.	D. S.
New Hampshire:			
Concord	4,330 ft.	634 ft.	Standard
Laconia	2,175 ft.	.....	Standard
New Jersey:			
Bayonne	10,000 ft.	1,250 ft.	Both
Long Branch	16,000 ft.	.....	Standard
Newark	11,802 ft.	.....	Standard
New Brunswick	3,672 ft.	1,215 ft.	Standard
Phillipsburg	218 ft.	.....	.....
Plainfield	6,910 ft.	.....	.....
Rahway	1,200 ft.	.....	Standard
Summit	400 ft.	.....	Standard
Westfield	2,200 ft.	6,600 ft.	D. S.
New Mexico:			
Albuquerque	6,200 ft.	.....	.....
Santa Fe	7,605 ft.	.....	Standard
New York:			
Binghamton	9,137 ft.	274 ft.	D. S.
Cortland	5,300 ft.	.....	.....
Elmira	13,929 ft.	.....	Standard
Endicott	18,830 ft.	.....	Standard
Geneva	5,000 ft.	.....	.....
Herkimer	2,600 ft.	.....	.....
Ilion	2,100 ft.	300 ft	.....
Johnson City	2,950 ft.	.....	Standard
Kingston	3,108 ft.	.....	.....
N. Y.—Manhattan	3,093 ft.	.....	Standard
Oneida	2,250 ft.	.....	Standard
Schenectady	22,359 ft.	2,115 ft.	Standard
Tarrytown	3,000 ft.	.....	Standard
North Carolina:			
Gastonia	10,000 ft.	.....	D. S.
Greenshoro	3 mi.	.....	.....
Rocky Mount	4.3 mi.	1.5 mi.	D. S.
Wilmington	4,241 ft.	.....	.....
North Dakota:			
Fargo	7,329 ft.	.....	D. S.
Jamestown	1,855 ft.	.....	Standard
Minot	6,500 ft.	.....	.....
Ohio:			
Akron	41,712 ft.	580 ft.	Both
Alliance	1,600 ft.	760 ft.	24" was D. S.
Ashtabula	492 ft.	.....	.....
Bowling Green	3,000 ft.	.....	.....
Chillicothe	2,696 ft.	.....	.....
Circleville	2,857 ft.	2,450 ft.	Over 24" D. S
Columbus	31,484 ft.	3,148 ft.	Over 10" D. S.

Vitrified Clay Pipe Laid in 1922—(Cont.)

City	Less than 24-inch	24 to 36-inch	Standard or double strength
Ohio (Continued)			
Dayton	22,705 ft.	860 ft.	Over 12" D. S.
East Cleveland	2,312 ft.	.....	Standard
Findlay	4,098 ft.	.....	Standard
Fostoria	600 ft.	.....	.....
Fremont	950 ft.	.....	D. S.
Lakewood	26,194 ft.	4,114 ft.	Over 12" D. S.
Lancaster	9,700 ft.	.....	Standard
Logan	3,000 ft.	.....	Standard
Mansfield	18,000 ft.	.....	Standard
Marion	750 ft.	.....	Standard
Middletown	9,415 ft.	.....	.....
Newark	11,510 ft.	1,608 ft.	Standard
Urbana	5,500 ft.	.....	Over 15" D. S.
Zanesville	17,700 ft.	1,640 ft.	D. S.
Oklahoma:			
Ada	2,500 ft.	200 ft.	Standard
Henryetta	19,350 ft.	1,870 ft.	.....
Muskogee	19,350 ft.	.....	Standard
Vinita	500 ft.	.....	.....
Oregon:			
Astoria	15,150 ft.	128 ft.	.....
Oregon City	1,000 ft.	.....	.....
Portland	2,618,686 ft.	61,998 ft.	.....
Pennsylvania:			
Allentown	45,341	.....	Standard
Chambersburg	5,000 ft.	.....	Standard
Clairton	3.47 mi.	.....	.....
Clearfield	4,200 ft.	.....	Standard
Connellsville	2,569 ft.	.....	Standard
Du Bois	2,516 ft.	.....	Standard
Dunmore	2,100 ft.	.....	.....
Ellwood	4,000 ft.	.....	.....
Hanover	3,500 ft.	.....	.....
Hazleton	19.85 mi.	.....	.....
Lebanon	11,600 ft.	.....	D & W. Socket
Luzerne	583 ft.	.....	D. S.
Meadville	5,042 ft.	.....	Standard
New Brighton	4,500 ft.	480 ft.	D. S.
New Castle	0.499 mi.	.....	.....
Norristown	2,000 ft.	.....	.....
Oil City	10,546 ft.	.....	Standard
Pittsburgh	46,037 ft.	3,446 ft.	D. S.
Pottsville	2,800 ft.	312 ft.	Standard
Rankin	200 ft.	200 ft.	Both
Sharon	14,594 ft.	2,046 ft.	Standard
Uniontown	4,000 ft.	.....	.....
York	1.5 mi.	.....	.....
Rhode Island:			
Pawtucket	8,190 ft.	742 ft.	Over 15" D. S.
Providence	191.63 mi.	.....	Standard
Westerly	18,845 ft.	.....	Both
Woonsocket	5,721 ft.	1,128 ft.	D. S.
South Carolina:			
Chester	532 ft.	.....	Standard
Greenville	1,500 ft.	600 ft.	Standard
Orangeburg	5,350 ft.	1,350 ft.	.....
Union	15,840 ft.	.....	.....
South Dakota:			
Aberdeen	9,000 ft.	1,000 ft.	.....
Watertown	1,400 ft.	.....	Standard
Tennessee:			
Clarksville	2,085 ft.	.....	.....
Cleveland	600 ft.	.....	.....
Dyersburg	75,000 ft.	.....	.....
Jackson	5,000 ft.	2,000 ft.	24" D. S.
Texas:			
Abilene	33,000 ft.	.....	.....
Amarillo	63,360 ft.	.....	Standard
Beaumont	6,000 ft.	.....	.....
Denison	4,600 ft.	.....	Standard
Denton	20,972 ft.	.....	Standard
Ennis	8,252 ft.	.....	Standard
San Angelo	1,200 ft.	.....	.....
Tyler	18.2 mi.	.....	.....
Weatherford	8,000 ft.	.....	Standard
Utah:			
Salt Lake City	47,600 ft.	.....	Standard
Virginia:			
Bristol	60,000 ft.	.....	Standard
Richmond	147,509 ft.	6,508 ft.	Standard
Staunton	2,456 ft.	.....	Standard
Washington:			
Port Angeles	2,877 ft.	.....	.....
Spokane	35,600 ft.	2,500 ft.	Over 12" D. S.
Yakima	43,775 ft.	4,875 ft.	D. S.
West Virginia:			
Bluefield	18,617 ft.	390 ft.	Standard
Fairmont	6,000 ft.	.....	.....
Morgantown	23,720 ft.	3,525 ft.	D. S.
Wisconsin:			
Baraboo	1,800 ft.	.....	.....
Madison	7,848 ft.	.....	D. S.
Oshkosh	7,200 ft.	.....	.....
Two Rivers	10,000 ft.	.....	Standard
Wausau	9,565 ft.	.....	.....

[a]—Also deep and wide sockets.

Note: Only two cities reported vitrified pipe larger than 36-inch—Kalamazoo, Mich., 2,969 feet, and Bayonne, N. J., 1,400 feet.

PIPE SEWERS OTHER THAN VITRIFIED CLAY LAID IN 1922

City	Cement Concrete Pipe: Less than 24-inch	Cement Concrete Pipe: 24 to 36-inch	Cement Concrete Pipe: Larger than 36-inch	Other Kinds of Pipe: Kind	Other Kinds of Pipe: Length	Other Kinds of Pipe: Size
Alabama:						
Dothan	....	600 ft.	....	.....	....	....
California:						
Napa	100 ft.	....	....	.....	....	....
Palo Alto	11,251 ft.	....	....	.....	....	....
San Diego	70 miles	....	....	Cast iron and kalamein	....	....
Stockton	23,783 ft.	1,396 ft.	....	.....	....	....
Colorado:						
Longmont	1,940 ft.	150 ft.	....	.....	....	....
Florida:						
St. Petersburg	600 ft.	....	....	Cast iron	1,300 ft	8 to 20 in.
Indiana:						
Elwood	....	....	....	Corrugated galvanized	500 ft.	....
Lafayette	....	2,810 ft.	....	.....	....	....
Seymour	....	....	....	Corrugated galvanized	192 ft.	16 in.
Iowa:						
Davenport	....	616 ft.	....	Cast iron	482 ft.	16 in.
Oelwein	....	....	....	Cast iron	200 ft.	10 in.
Red Oak	....	1,800 ft.	....	.....	....	....
Kentucky:						
Madisonville	....	....	....	Cast iron	300 ft.	10 in.
Maryland:						
Hagerstown	....	....	162 ft.	Cast iron	1,282 ft.	5, 20 & 24 in.
Massachusetts:						
North Adams	....	....	....	Cast iron	24 ft.	10 & 12 in.
Michigan						
Battle Creek	....	....	1,404 ft.	.....	....	....
Flint	3,097 ft.	....	6,481 ft.a	Cast iron siphons	625 ft.	8 to 20 in.
Minnesota:						
Hibbing	1,500 ft.	....	....	.....	....	....
Minneapolis	....	....	....	Cast iron	270 ft.	8 in.
Missouri:						
Joplin	21,790 ft.	....	....	.....	....	....
Kansas City	....	....	5,625 ft.	.....	....	....
Mississippi:						
Hattiesburg	1,925 ft.	1,030 ft.	....	.....	....	....
Nebraska:						
Kearney	235 ft.	....	....	.....	....	....
Omaha	10,000 ft.	....	3,100 ft.	.....	400 ft.	12 to 24 in.
New Jersey:						
Bayonne	....	....	4,000 ft.	.....	....	....
Newark	165 ft.	7,146 ft.	....	Cast iron	36 ft.	12 in.
New Brunswick	....	1,450 ft.	40 ft.	.....	....	....
Plainfield	....	2,237 ft.	350 ft.	.....	....	....
New Mexico:						
Albuquerque	....	1,500 ft.	....	.....	....	....
New York:						
Cortland	300 ft.	....	....	.....	....	....
Johnson City	....	2,470 ft.	....	.....	....	....
Johnstown	1,475 ft.	....	....	.....	....	....
Ogdensburg	....	850 ft.	....	.....	....	....
Schenectady	1,217 ft.	....	308 ft.	.....	....	....
North Carolina:						
Wilmington	6,815 ft.	692 ft.	200 ft.	.....	....	....
North Dakota:						
Fargo	....	....	....	Cast iron	....	36 to 48 in.
Ohio:						
Alliance	....	1,170 ft.	800 ft.	.....	....	....
Circleville	....	....	....	Cast iron	72 ft.	20 in.
Lancaster	....	900 ft.	....	.....	....	....
Logan	....	....	....	Cast iron	75 ft.	36 in.
Mansfield	1,000 ft.	....	....	Cast iron	400 ft.	12 in.
Urbana	1,500 ft.	....	....	.....	....	....
Oklahoma:						
Ada	....	....	....	Steel	800 ft.	12 in.
Oregon:						
Portland	915,664 ft.	19,557 ft.	....	Wood	404 ft.	....
Pennsylvania:						
Allentown	....	....	....	Cast iron	370 ft.	18 in.
Ellwood City	....	....	....	Corrugated iron	300 ft.	8 to 15 in.
Hazleton	....	....	2.9 miles	.....	....	....
Norristown	900 ft.	....	....	.....	....	....
Oil City	....	....	....	Cast iron	532 ft.	6 & 12 in.
Pittsburgh	....	736 ft.	....	.....	....	....
South Carolina:						
Greenville	....	....	....	Cast iron	240 ft.	8 in.
Orangeburg	600 ft.	1,750 ft.	....	.....	....	....
Spartanburg	6.8 miles	....	....	.....	....	....
South Dakota:						
Watertown	860 ft.	710 ft.	....	.....	....	....
Tennessee:						
Cleveland	600 ft.	....	....	.....	....	....
Texas:						
Abilene	....	....	....	Cast iron	180 ft.	18 in.
Eastland	....	1,940 ft.	....	.....	....	....
Heatherford	....	1,200 ft.	....	.....	....	....
Tyler	....	....	....	Cast iron	130 ft.	6, 8 & 12 in.
Utah:						
Ogden	....	....	32,935 ft.	.....	....	....
Salt Lake City	....	375 ft.a	....	.....	....	....
Virginia:						
Bristol	....	....	....	Cast iron	....	....
Washington:						
Port Angeles	15,465 ft.	....	....	.....	....	....
Spokane	3,500 ft.	1,300 ft.a	3,480 ft.a	.....	....	....
Tacoma	13,090 ft.	11,563 ft.	....	.....	....	....
Walla Walla	1,500 ft.	....	....	.....	....	....

a—Reinforced.

SEWERS OTHER THAN PIPE LAID IN 1922

City	Brick Length	Brick Dimensions	Concrete Length	Concrete Dimensions	Reinforced?	Vitrified Clay Segment Block Length	Vitrified Clay Segment Block Dimensions
Alabama:							
Dothan	....	.....	1,050′	.....	No	....	.....
Colorado:							
Longmont	....	.....	1,105′	2½′ x 3½′ box culv.	Partially	....	.....
Florida:							
Sanford	....	.....	....	.....	...	900′ 1,400′	36″ 33″
Illinois:							
Kewanee	½ mi.	36″ to 60″	....	.....	...	....	.....
Quincy	64,670′	2x3 egg to 6.6 circular	....	.....	....	....	.....
Indiana:							
Indianapolis	....	.....	....	.....	...	11,800′	2′-6″ to 6′
Washington	....	.....	460′	5′ x 6′	....	....	.....
Iowa:							
Davenport	....	.....	....	.....	..	6,956′	42″
Kansas:							
Emporia	....	.....	175′	30″ square	Yes	280′ 400′ 760′ 391′ 965′	42″ 48″ 54″ 84″ 96″
Wichita	....	.....	....	.....	....	3,960′	.....
Kentucky:							
Ashland	2,407′	54″	....	.....	....	....	.....
Paducah	....	.....	2,000′	8½′x8½′ semi-elipt.	Yes	....	.....
Maryland:							
Hagerstown	....	.....	162′	84″ and 66″	No	....	.....
Massachusetts:							
Worcester	....	.....	310′ 1,084′	54″ x 84″ 72″ round	No Yes	....	.....
Michigan:							
Battle Creek	26,994′	1′-10″ x 2′-9″ to 3′-4″ x 5′-2″	4,180′	30″ to 3′-6″ x 4′-6″	No	6,288′	30″ to 42″
Kalamazoo	....	.....	....	.....	....	10,530′	30″ to 54″
Minnesota:							
Austin	....	.....	....	.....	....	2,813′	42″
Brainerd	....	.....	3,750′	48″ and 54″	Yes	....	.....
Faribault	....	.....	....	.....	....	2,917′	36″
Minneapolis	75′	24″ and 42″ egg	9,302′	39″ egg to 102″	Yes	2,420′	36″ to 42″
New Ulm	900′	36″	3,747′	33″ to 54″	No	2,795′	30″ to 42″
Mississippi:							
Hattiesburg	....	.....	1,655′	4′ x 6′ to 3′-6″ x 10′	Yes	....	.....
Missouri:							
Kansas City	....	.....	5,625′	.....	Yes	1,783′	.....
St. Louis	....	.....	2,869′	6′ to 12′ horseshoe	Yes	....	.....
Nebraska:							
Kearney	....	.....	4,260′	2′-6″ x 4′-6″ rectang.	Yes	....	.....
Lincoln	....	.....	....	.....	....	4,474′	.....
Omaha	6,210′ 212′	3′ to 13′ 4′ to 11′ brick and concrete	1,593′	3′-3″ to 11′-3″ x 17′	Yes	....	.....
New Jersey:							
Newark	....	.....	2,198′	.....	Yes	....	.....
New Mexico:							
Albuquerque	....	.....	1,500′	.....	Yes	....	.....
New York:							
N. Y.—Manhattan	1,720′	2′-4″ x 3′-6″	1,460′	2′-4″ x 3′-6″	Yes	....	.....
Schenectady	....	.....	1,000′	5′ x 6′	Yes	....	.....
North Carolina:							
Gastonia	....	.....	3,000′	6′ x 7′	Yes	....	.....
North Dakota:							
Fargo	....	.....	114′	48″ circ.	Yes	....	.....
Ohio:							
Akron	....	.....	....	.....	....	32,210′	24″ to 126″
Columbus	....	.....	....	.....	....	7,853′	30″ to 42″
Dayton	....	.....	18,062′	30″ to 66″	No	....	.....
Lakewood	....	.....	....	.....	....	1,422′	45″
Oklahoma:							
Henryetta	....	.....	....	.....	....	7,460′	30″ to 66″
Oregon:							
Portland	102,520′	.....	316,708′	.....	25%	1,393′	.....
Pennsylvania:							
Chambersburg	....	.....	300′	5′ x 4′	Yes	....	.....
Norristown	....	.....	900′	.....	No	....	.....
Pittsburgh	9,759′	30″ to 84″ x 93″	7,330′	48″ to 84″ x 120″	No	....	.....
York	300′	42″	....	.....	....	....	.....
Rhode Island:							
Pawtucket	44′	36″	1,425′	60″ and 66″	No	1,910′	60″ and 66″
Providence	91.97 ml.	.....	5,183′	.....	Yes	2,048′	.....
South Dakota:							
Aberdeen	....	.....	....	.....	....	1,100′	30″
Texas:					No		
Beaumont	....	.....	700′	2½′ x 2′ horseshoe	Yes	....	.....
			3,000′	4′ x 7′ box	Yes	....	.....
Eastland	....	.....	2,300′	5′ diameter	No	....	.....
Virginia:							
Richmond	140′	36″ circ.	155′ 2,762′	5′ x 5′ box 9′ invert. horseshoe	Yes	20,280′	30″ to 57″
Washington:							
Port Angeles	1,304′	.....	....	.....	....	....	.....
West Virginia							
Bluefield	....	.....	360′	2.5′ x 4′ and 6′ x 8′	75%	....	.....
Wisconsin:							
Madison	....	.....	1,137′	2.5′ x 3′	No	....	.....
Oshkosh	....	.....	4,000′	.....	No	....	.....

LABOR-SAVING DEVICES

City	Devices used by city or contractor in constructing sewers: Kind	Length of trench used on	Devices used for cleaning sewers: Kind	Amount of work done
Arizona:				
Tucson	.....	.....	Self-propelling nozzle	800 ft.
Arkansas:				
Pine Bluff	Austin trenching machines and Austin backfiller.	40,750 ft.	.....	.....
California:				
Palo Alto	Trench excavating machine	13,600 ft.	.....	.....
Pasadena	Trench excavating machine	.....	Turbine	.....
San Diego	Compressed air pavement breaker and steam and gasoline excavators	Many miles	.....	.....
San Louis Obispo	Trenching machine	11,000 ft.	.....	.....
Colorado:				
Longmont	.....	.....	Sewer rods	.....
Connecticut:				
Hartford	Keystone excavator	4,400 ft.	Winch and bucket	.....
New Haven	Keystone and Erie	.....	Flushing carts	.....
Georgia:				
La Grange	Austin excavator	78,600 ft.	.....	.....
Illinois:				
Centralia	P. & H. backfiller	.....	Turbine cleaner	.....
Johnson City	P. & H. backfiller, Buckeye and P. & H. excavators	.....	.....	.....
Kewanee	.....	.....	Rods and hose	.....
Normal	.....	.....	Turbine	.....
Quincy	Trench machines	120,000 ft.	Name not given	.....
Indiana:				
Elwood	.....	.....	Champion cleaner	4 miles
Gary	Erie, Keystone, Monighan	.....	2 Kuhlman outfits	Always busy
Indianapolis	Keystone, Austin and Parsons excavators	.....	.....	.....
Lafayette	Austin excavator, Parsons backfiller	.....	.....	.....
Peru	Austin excavator and backfiller	3,000 ft.	Self-propelling nozzle	All sewers
Wabash	.....	.....	Sewer rods, cutting tools	.....
Iowa:				
Atlantic	.....	.....	Stewart	.....
Creston	Austin trencher and backfiller	3,450 ft.	.....	
Keokuk	.....	.....	Flexible steel rod	.....
Mt. Pleasant	Austin trencher and backfiller	23,000 ft.	.....	.....
Oelwein	Austin trencher and backfiller	.....	.....	.....
Kansas:				
Atchison	.....	.....	Rods and hose	.....
Dodge City	Humphrey trencher	31,000 ft.	.....	.....
Emporia	Steam shovel, trenching machine	2,000, 25,000 ft.	.....	.....
Independence	.....	.....	Self-propelling nozzle, Stewart rods	.....
Topeka	Keystone comb. ditcher and shovel, Omaha trench excavator	.....	.....	.....
Wichita	Trench machines, pavement breakers, backfiller	10, ½, 2 mi.	Champion	Constant use
Kentucky:				
Louisville	Keystone	1 mile	Stewart	.....
Madisonville	2 Austin trenching machines	39,000 ft.	.....	.....
Paducah	Parsons trencher, Type B; Erie shovels, backfiller	.....	.....	.....
Louisiana:				.....
Lake Charles	.....	.....	Jointed rods	.....
Maine:				
Augusta	.....	.....	Rods	.....
Portland	Carson trench machine	2,200 ft.	Stewart	General use
Maryland:				
Hagerstown	Keystone and Carson	24,800 ft.	Victory	2,000 ft.
Massachusetts:				
Adams	Steam shovels	Depth of 4 ft.	.....	.....
Brockton	Parsons excavator and backfiller	14,000 ft.	.....	.....
Cambridge	.....	.....	Healey	.....
Natick	.....	.....	Rods, with cutters and cork-screw	.....
Peabody	.....	.....	Stewart machine	5 miles
Worcester	Erie shovel, Byers' auto-crane	.....	.....	.....
Michigan:				
Battle Creek	.....	.....	Turbine sewer cleaner	4,000 ft.
Dowagiac	.....	.....	Self-propelling nozzle, rods	.....
Flint	Steam shovel, Potter machine, Austin trencher	1,564, 1,018, 38,000 feet	.....	.....
Hastings	.....	.....	Self-propelled nozzle	.....
Marquette	.....	.....	Turbine	
Niles	Austin trencher and backfiller	10,000 ft.	Rods, cable and hose	.....
Minnesota:				
Austin	Monighan, clamshell, Austin and Parsons trenching machines	70,000 ft.	.....	.....
Cloquet	Excavator and backfiller	2,000 ft.	Self-propelling nozzles and rods	500 ft.
Faribault	Austin trencher and backfiller	5,378 ft.	Rods	.....
Minneapolis	Ladder-type P. H. excavator, 3 steam hoists, 6 gas hoists, 2 pile drivers, 6 steam sheetpile drivers, steam and gas pumps, gas backfillers, concrete mixers	.....	Scrapers, discs, etc.	.....
St. Cloud	Excavator and backfiller	5,400 ft.	Turbine	.....
Stillwater	Parsons and Austin trenchers Austin and P. & H. backfillers	20,057 ft.	.....	.....
Missouri:				
Maplewood	Trencher and backfiller	4,500 ft.	Jointed rods	.....
St. Louis	Trench excavator	.....	.....	.....
Montana:				
Billings	Austin trencher	3,300 ft.	.....	.....
Bozeman	Austin trencher	2,328 ft.	Self-propelling nozzle, steel brushes and cable	

LABOR-SAVING DEVICES—Continued

Kalispell	.....	.....	Rods	.....
Livingston	.....	.....	Rods	.....
Nebraska:				
Kearney	.....	.....	Rods and gigs	.....
Lincoln	Trench machines	30,000 ft.	Self-propelling nozzles	.....
Omaha	P. & H., Parsons, Austin Humphrey	.....	.....	.....
New Hampshire:				
Laconia	.....	.....	Victory nozzle and root cutter	.....
New Jersey:				
Bayonne	Steam shovels, trenchers	.....	.....	.....
Newark	Keystone excavator	.....	Turbine	.....
New Brunswick	.....	.....	Self-propelling nozzle and rods	.....
Phillipsburg	.....	.....	Self-propelling nozzle	.....
Plainfield	Keystone excavator, tamper	.....	.....	.....
Summit	.....	.....	Cable, brushes and root cutters	1 mile
Westfield	Keystone No. 6	7,000 ft.	.....	.....
New Mexico:				
Albuquerque	Sheetpile drivers	1,200 ft.	Self-propelling nozzle	2,000 ft.
Santa Fe	.....	.....	Rods	.....
New York:				
Binghamton	Austin trencher and backfiller	.....	Turbine	.....
Cortland	Keystone excavator	.....	.....	.....
Elmira	Austin trencher, Keystone	10,871, 2,758 ft.	Victory nozzle	.....
Endicott	Austin trencher, Austin backfiller	13,800 ft.	.....	.....
Johnson City	Austin trencher and backfiller	.....	.....	.....
Johnstown	.....	.....	Sewer rods	.....
Schenectady	Excavating machine	3,500 ft.	Turbine	3,000 ft.
North Carolina:				
Rocky Mount	Austin excavator	.....	Rods and cable	.....
Wilmington	.....	.....	Stewart	.....
North Dakota:				
Fargo	.....	.....	Rods	.....
Jamestown	Buckeye ditcher, home-made backfiller	1,855 ft.	.....	.....
Minot	Parsons trencher	.....	.....	.....
Ohio:				
Akron	Austin	.....	.....	.....
Alliance	Keystone	3,200 ft.	.....	.....
Ashtabula	Thew steam shovel	7,000 ft.	Turbine	5 miles
Columbus	Keystone, Austin & steam shovel	.....	.....	.....
Dayton	.....	.....	Turbine	18,600 ft.
Findlay	.....	.....	Self-propelling nozzle; rods and cable with cutting tools	.....
Mansfield	Parsons trencher	.....	.....	.....
Martins Ferry	.....	.....	Special nozzle	Daily
Middletown	Austin	6,800 ft.	.....	.....
Newark	Keystone	.....	Kuhlman	.....
Urbana	Trench excavators	7,000 ft.	Stewart outfit	.....
Zanesville	Trenching machines and back fillers	14,000 ft.	.....	.....
Oklahoma:				
Ada	Austin excavator; backfiller	.....	.....	.....
Henryetta	Steam shovel; Austin trencher	7,000; 15,000 ft.	.....	.....
Oregon:				
Portland	Excavators, clam-shells, steam shovels	.....	Turbine	Tree roots
Pennsylvania:				
Allentown	Keystone	.....	.....	.....
Chambersburg	.....	.....	Turbine	.....
Clairton	Erie ½ yd. shovel	1½ miles	Self protecting nozzle	.....
Ellwood City	Steam shovel with trenching scoop	.....	Rotary nozzle	.....
Hazelton	Steam shovel	3,000 ft.	.....	.....
Lebanon	Keystone	.....	.....	.....
Luzerne	.....	.....	Victory nozzle	500 ft. of 30 in.
Meadville	.....	.....	Root cutting machine	Two points
Monessen	.....	.....	Self-propelling nozzle	500 ft.
New Brighton	Keystone	3,490 ft.	.....	.....
Norristown	.....	.....	Stewart and Turbine	Several miles
Oil City	Keystone	.....	.....	.....
Pittsburgh	Compressed air asphalt cutters; steam shovel, clam and dipper	.....	.....	.....
Sharon	Keystone	11,420 ft.	Stewart	2 miles
Uniontown	.....	.....	Self-propelling nozzle	.....
Rhode Island:				
Pawtucket	Trench excavator	4,300 ft.	Stewart	.....
Providence	Austin and Parsons	.....	.....	.....
South Carolina:				
Chester	.....	.....	Stewart	.....
Greenville	.....	.....	Liberty nozzle	.....
Orangeburg	.....	.....	Self-propelling root cutter	1,500 ft.
Texas:				
Abilene	Austin gasoline trencher	33,000 ft.	.....	.....
Amarillo	Austin backfiller	63,360 ft.	.....	.....
Beaumont	Monighan drag-line	.....	Whirling nozzle	1,000 ft.
Eastland	Backfiller	2,000 ft.	Self-propelling nozzle	1,500 ft. of 6" & 8"
Utah:				
Salt Lake City	P. & H. Trencher	375 ft.	.....	.....
Virginia:				
Richmond	Keystone; Austin cranes and trenchers	.....	.....	.....
Washington:				
Port Angeles	Parsons No. 30	14,974 ft.	.....	.....
Spokane	.....	.....	Turbine	.....
Takoma	.....	.....	"Ferret"	.....
Yakima	P. & H. dragline excavator	7,832 ft.	.....	.....
West Virginia:				
Morgantown	.....	.....	Root cutting nozzle	.....
Wisconsin:				
Baraboo	.....	.....	Turbine	2,000 ft.
Madison	.....	.....	Chicago turbine	.....
Oshkosh	.....	.....	Milwaukee turbine	.....
Two Rivers	.....	.....	Turbine	.....
Wausau	.....	.....	Milwaukee turbine	.....

Recent Legal Decisions

CONSTRUCTION OF SEWAGE DISPOSAL PLANT OUTSIDE CITY LIMITS AUTHORIZED

It is a matter of common knowledge that, though sewers are usually laid in streets, the outlets, flush tanks, septic tanks and other similar appurtenances which take care of the sewage flowing through and from sewers, are seldom, if ever, constructed in the streets. The California Court of Appeals, Second District (hearing denied by the Supreme Court), Federal Const. Co. v. Ensign 210 Pac. 536, holds that a statute, such as the California Improvement Act of 1911, empowering city councils to construct sewers in streets, with outlets, flush tanks, septic tanks, connecting sewers and other appurtenances "in, over or through property or rights of way owned by such city," empowers a city to construct a sewage disposal plant on its property two miles outside the city limits, connected with its sewer system over its right of way.

CONTRACTOR CONSTRUCTING DITCH ACCORDING TO PLANS AND SPECIFICATIONS NOT REQUIRED TO REMOVE SILT WASHED INTO IT AFTERWARDS

The Minnesota Supreme Court, Friederick v. Redwood County, 190 N. W. 801, states the general rule as to a contractor's duty to repair defects in work done as follows: Where a contractor makes an absolute and unqualified contract to perform a given undertaking, he assumes the risks attending the performance of the contract, and must repair any defect which develops before the completion of the work. But when he contracts to perform a given undertaking according to prescribed plans and specifications, he fulfills his engagement by doing the prescribed work in the prescribed manner, and is not responsible for defects unless due to some fault on his part, in the absence of any provision in the contract imposing some other or further obligation. So it is held that where a contractor constructs a ditch according to the plans and specifications therefor, he is not required to remove earth and silt washed into it after it was constructed unless there be a provision in the contract to that effect.

SPECIAL ASSESSMENTS FOR SEWERS—NEBRASKA

The Nebraska Supreme Court holds, Hurd v. Sanitary Sewer Dist. No. 1 of Harvard, 191 N. W. 438, that the erection of a sewage disposal plant is a general improvement, the cost of which cannot be levied upon real estate by special assessment for benefits; and the cost of main sewers in excess of special benefits can only be paid for by general taxation. A sewer assessment should be confined to lots abutting on the improvement, and there should be a finding by the board that the several lots assessed were benefited to the extent of the assessment. If the foot frontage rule is adopted there should be a finding that the benefits are equal and uniform. The court sees no reason for assessing a business lot twice as much as a residence lot.

FINAL CERTIFICATE AS EVIDENCE OF PERFORMANCE OF CONTRACT

Where a contract with a city for the erection of a bridge provided that no certificate or payment under the contract "except the final certificate or final payment, shall be evidence of the performance of this contract," the New York Appellate Division holds, Eyre v. Wood, 196 N. Y. Supp. 696, that the final certificate of the engineer, though some evidence, is not conclusive exidence of full performance.

RECOVERY ON CONTRACTOR'S BOND ON UNCOMPLETED ROAD CONTRACT

A county road-building contract required the contractor to furnish all work and material in the performance thereof. He purchased from the county court, at a reasonable price, useful and necessary machinery and material to be used in the work and to be paid for out of the moneys due him under the contract. He failed to complete the work, and the county court took it over and finished it under the terms of the contract. The West Virginia Supreme Court of Appeals holds, State v. Smith, 114 S. E. 375, that in a suit on the contractor's bond for the excess money spent in completing the contract, the county court is entitled to take the money due it for machinery and material from whatever sum was due the contractor when he quit the work, and recover from him and his bondsman the excess expenditures, less such credits and set-offs as he might be entitled to.

SPECIFICATIONS FOR PUBLIC WORKS HELD TOO INDEFINITE

The Court of Errors and Appeals of New Jersey holds, Tice v. Commissioners of City of Long Branch, 110 Atl. 25, that specifications for public work should be precise and definite upon all the essential elements that enter into the competitive scheme. Where there is no common standard there is no competition. Whatever element enters into the competitive scheme, it should be the same for all, not left for each bidder to fix for himself and thereby estimate his bid upon a basis different from that of any other bid. Following this rule, specifications inviting bids for the collection and removal of garbage, in which there is no method of disposal provided for, were held too indefinite and uncertain. A municipal contract awarded thereunder was therefore set aside.

COUNTIES NOT LIABLE FOR NEGLIGENCE OF THEIR OFFICIALS

The Iowa Supreme Court holds, Post v. Davis County, 191 N. W. 129, that, since a county is a political organization and merely a part of the organization of the state, there is no more reason or legal principle for holding the county liable for damages for negligence of its officials than the state liable for such damages for negligence of its officials.

PUBLIC WORKS.
CITY COUNTY STATE
A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"
Vol. 54 August, 1923 No. 8

Constructing Mitchell Dam

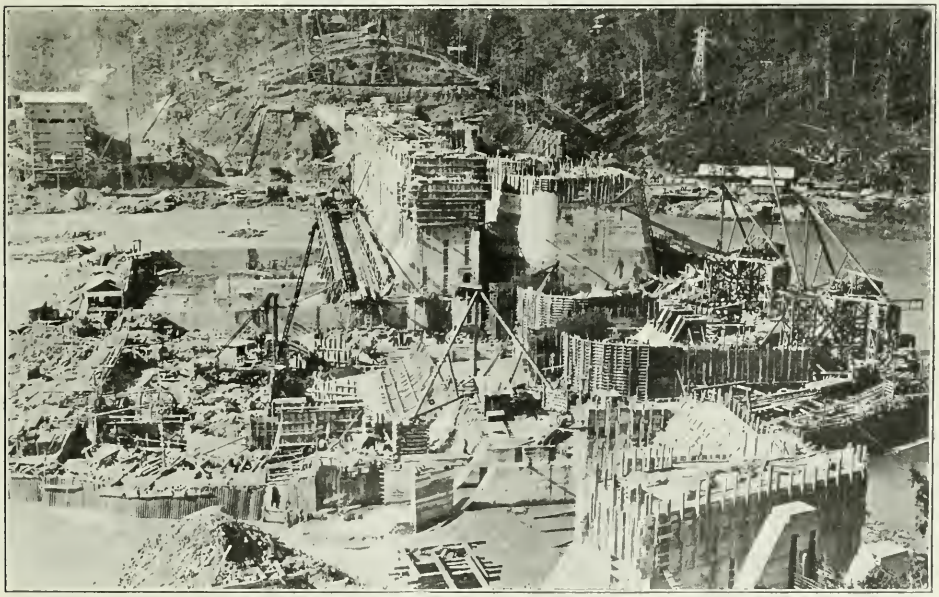
Construction of cofferdams in a wide, swift stream as preliminary work in development of a power project for the Alabama Power Company

By L. G. WARREN*

In the May issue of PUBLIC WORKS under the title "Super-Power Electric Systems," PUBLIC WORKS referred to the southern super-power system, which contains more than 600 miles of distribution line and nine generating stations and six main distributing centers. One of the cooperating companies in this system is the Alabama Power Company. This company has hydroelectric generating stations at Jackson Shoals, 3,000 h. p., and one at Lock No. 12, about 60 miles below Birmingham, producing 110,000 h. p.; also reserve steam plants on Warrior river, 77,000 h. p., at Gadsden, 20,000 h. p., and at Birmingham, 15,000 h. p. The company has 1,500 miles of transmission lines feeding the various industries and communities of the state. The main distribution line carries a current of 110,000 volts, which is stepped down to 44,000 volts at the primary sub-stations, which have a total capacity of 300,000 K. V. A.

Owing to the rapidly increasing demands of the Alabama industries for electric power, the company is constructing the Mitchell dam and hydroelectric plant on the Coosa river 12 miles down-stream from Lock 12. Construction on this dam started in July, 1921. Generation of power was started with one 24,000 h. p. gen-

*Principal assistant engineer for Dixie Construction Co.



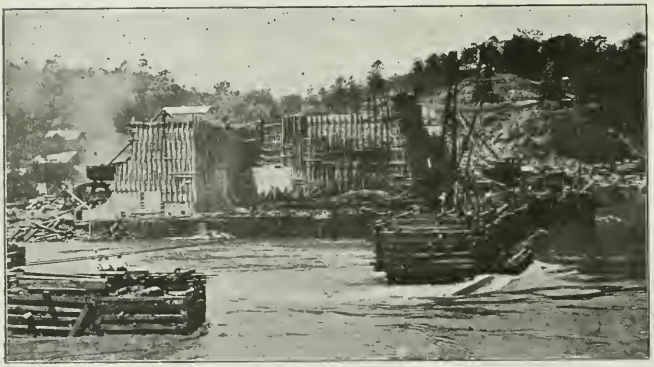
COFFERDAM NO. 3 ON NOVEMBER 8, 1922.
In left foreground, southeast arm with steel sheeting. Right foreground, river flowing through stream control gap. Forms for bridge deck piers, power houses No. 3 and No. 4 and cast abutment.

PLACING CRIB IN NO. 3 COFFERDAM.
Crib has just been deposited in water by crane. Cables suspend it from main cable across river, by which it is lowered (by means of blocks) as crib is built up and loaded.

the power houses involved 7,800 cubic yards of earth and 63,600 cubic yards of rock. The construction will require approximately 203,000 cubic yards of concrete and about 1,285 tons of reinforcing steel.

There will be four power houses, which will be placed upstream from the dam and form an integral part of it. This design eliminated the necessity of the usual power house building. Each power house rests on a separate foundation. Each will contain an electric generating unit of 24,000 h. p. capacity, the turbines being furnished by the Allis-Chalmers Company and the generators by the General Electric Company. The effective head on the turbines is 70 feet.

The reservoir created by the dam has a capacity of 58,230 million gallons of water, or 175,000 acre-feet. The area of the water surface with a full reservoir is 5,800 acres, and the length is 12 miles, or the entire distance from the dam to the company's hydroelectric plant at Lock No. 12.



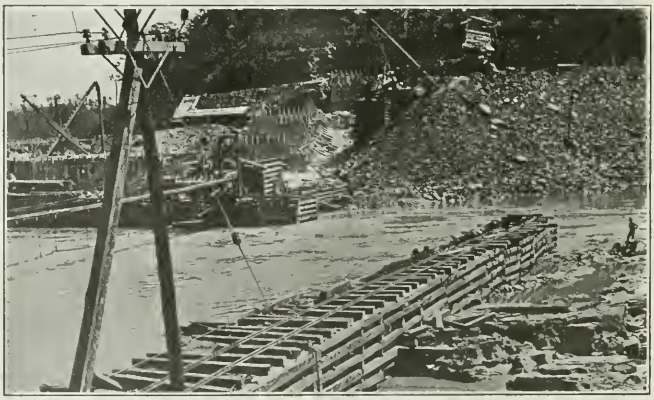
RIVER ALMOST STOPPED BY COFFERDAM NO. 3.
Northeast arm in left foreground; upstream arm in right foreground. Forms for main body of dam and power houses in background.

Above the spillway extends a bridge carried by piers 35 feet above the spillway crest. This carries standard gauge tracks from the main line railroad on the west bank to the eastern side of power house No. 4. A siding from this track passed under an overhanging reach of a 125-ton steel gantry crane, which has a runway so located that it can handle all equipment in the power house for installation and repairs. Each generator room is covered with a low roof, the center section of which is divided into two movable pieces mounted on trucks and supported on steel frames, the trucks being actuated by

erator on April 7 of this year, a second one early in June, and a third generator will probably be started about the middle of July.

The dam is of the gravity type, constructed of cyclopean concrete. The upstream face is straight and the downstream face is an ogee curve. The minimum width at the base is 74 feet 3 inches, and the width at the crest is 8 feet 3 inches. The length of the crest is 1,146 feet between abutments, and the spillway length is 930 feet, and the elevation of spillway is 335, which is 87 feet above the lowest point in the foundation and 70 feet above bed rock at the toe.

Excavation for the dam and



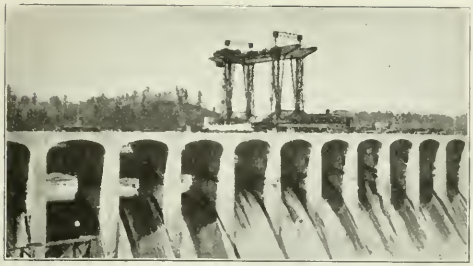
IN FOREGROUND, BEGINNING OF CONSTRUCTION OF DOWNSTREAM ARM OF COFFERDAM NO. 3.
Left background, cofferdam No. 2, forms for spillway section of dam, and steel cable suspension bridge between cofferdams No. 1 and No. 2.

motors. By removing this section of the roof the entire area over a generator unit can be exposed and the gantry crane can pick up any piece of equipment for repairs in place or for removal to the machine shop. This machine shop is adjacent to the west side of power house No. 1. In addition, the gantry crane can be used in raising and lowering penstock gates, trash racks, stop logs, etc.

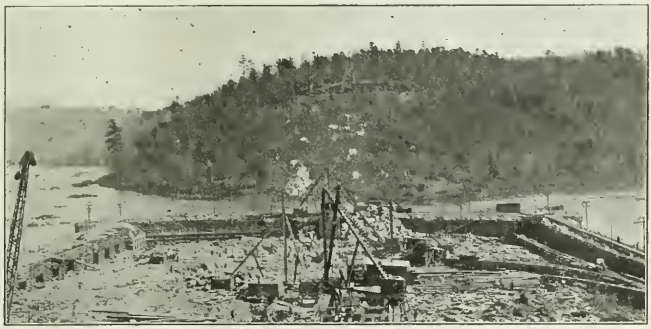
Between the main structures of the power houses and the up-stream face of the dam is a gallery at elevation 360, or 10 feet higher than the top of the flood gates on the dam, and extending from the west end of power house No. 1 to the eastern end of power house No. 4. In this gallery are situated the switchboards, the buss structures and office. The transformers are located on the roof of the operating room.

There are 26 flood or spillway gates of the Tainter type, each 15 feet high and 30 feet wide. They are mounted on end pins or shafts located in the bridge piers and are operated by electric motors, one for each pair of gates, with a clutch between the motor and each gate. It is calculated that these gates will pass the maximum recorded flood of the Coosa river. The bottom edge of the gate is at elevation 335 and the top edge at elevation 350. Six bays or spaces 30 feet long between bridge piers are provided as emergency spillways, four of them on the west end and two of them on the east end of the dam.

One of these spillways has its crest at elevation 355 and the other five at elevation 350.



DOWNSTREAM VIEW, SHOWING TAINTER GATES IN PLACE, AND GANTRY CRANE.



COFFERDAM NO. 3 DE-WATERED. TAIL TOWERS OF CABLEWAY IN BACKGROUND.

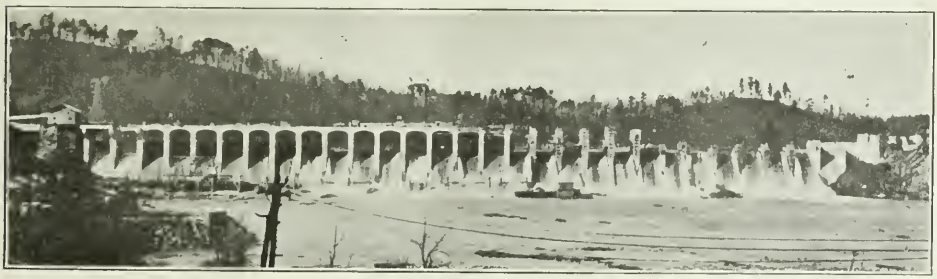
CONSTRUCTION OF THE DAM

Stream control was a major operation in the construction of the dam and the building of the cofferdams was accordingly one of the most important phases of the work and was started immediately upon the completion of the standard gauge extension from the Louisville & Nashville railroad to the dam, a distance of about eight miles.

The construction of cofferdam No. 1, the laying of narrow gauge tracks and the erection of mixing and crushing plants were begun simultaneously.

At the site of the dam the river is 1,000 feet wide. The general scheme of cofferdams was to divide the work into three sections—the western side of the river or cofferdam No. 1, the eastern side or cofferdam No. 2 and the middle or closure section or cofferdam No. 3.

Cofferdam No. 1 extended 550 feet into the river. The three arms of the dam enclosed an area 600 feet long and 400 feet wide, or about 5 acres. In this was located the excavation for two of the power houses as well as for the western section of the dam. The up-stream arm of the cofferdam was carried to elevation 290. This



VIEW FROM DOWN STREAM, SPILLWAY COMPLETED, BRIDGE DECK ABOUT HALF COMPLETED.

would allow 108,000 second-feet of water to flow in the open channel before overtopping the cofferdam.

The up-stream arm was composed of 24x24-foot cribs built of 10x10-inch timbers drift-bolted together. These cribs were filled with rock and double-sheathed on the exterior. Clay was deposited against the crib as a water seal. The down-stream arm was 16 feet wide and composed of two chambers—a line of rock-filled cribs 8x8 feet constructed of 8x8-inch timbers on the inner side, and the outer chamber of similar cribs filled with clay, with a clay toe on the exterior. The connecting or out-stream arm consisted of two lines of 12x12-foot rock-filled cribs separated by a clay chamber 6 feet wide for water seal. The exterior of this arm was sheathed with 2-inch timber.

For handling the timbers to the cofferdam, narrow gauge flat cars pulled by electric locomotives were employed, the track being laid on the cofferdam and maintained in close proximity to the timber-laying gangs. When the cofferdam had been finished the tracks completely encircled the enclosed area, which enabled the rapid handling of timbers and of excavation in the subsequent work. On the out-stream arm, timbers were handled to position with a travelling derrick, motor-driven, with a 35-foot boom. Pneumatic boring machines prepared holes for the drift bolts.

Eight months after beginning cofferdam No. 1, construction was started on No. 2. By this time two cableways were available for transporting timber and other material. This cofferdam was the smallest of the three, enclosing only 1/3 of an acre, being 136 feet long and 104 feet wide.

The up-stream and down-stream arms of this coffer were composed of 8x8-inch timber rock-filled and sheathed with 2-inch planks on the exterior with a clay toe deposited against it. The out-stream arm consisted of two chambers, one being built of 10x10-foot cribs using 8x8-inch timbers, sheathed on both sides with 2-inch lumber and rock-filled, while a clay chamber was constructed by means of a timber frame bolted to these cribs, which was filled with clay to act as a water seal. The construction of this coffer left a channel capable of passing 65,000 second-feet before flooding the coffers, this channel being 28 feet deep at the up-stream arms of the cofferdams.

Cofferdam No. 3, which formed a junction between numbers 1 and 2, had a maximum height of 40 feet above the river bed and presented the most serious problem of the three. It was 270 feet long and 330 feet wide, enclosing 2.9 acres. Two of the power houses as well as the center section of the dam were located in this area. The up-stream arm was carried to elevation 300 and had a maximum width of 36 feet. It was composed of rock-filled cribs 24 feet long by 36 feet wide, built of 12x12-inch timbers. On the exterior, U. S. steel sheet piling was driven to the river bed and a clay fill was made on the exterior of the sheeting to act as a water seal. The construction of this arm in the swift and deep water was a difficult task, but was handled in a novel manner. The first crib adjacent to cofferdam No. 1 was built in the usual manner, loading it with rock at intervals. A ¾-inch plow-steel cable was then suspended from an A-frame on this first crib to the opposite shore. The succeeding cribs were started on the first crib and lifted and supported in position in the water by a locomotive crane, and cables from blocks on the ¾-inch steel cable held the cribs at the proper alignment during the building of subsequent courses of timbers. The northeast arm of cofferdam No. 3 was a continuation of the out-stream arm of dam No. 2 and consisted of two lines of 16x16-foot rock-filled cribs of 12x12-inch timbers with a clay chamber 10 feet wide separating the lines of cribs and serving as a water seal. A clay fill was placed on the exterior also of this arm. The southeast arm was formed by a single line of 12x24-foot rock-filled cribs with U. S. steel sheet piling driven to river bottom along the exterior. The down-stream arm, with top elevation of 285, was composed of 8x12-foot rock-filled cribs sheathed on the exterior with lumber, against which a clay toe was deposited.

Just before the up-stream arm of cofferdam No. 3 was closed, stream control passages 12 feet wide in cofferdam No. 1 were opened, allowing the river to flow through them and through the eight stream control passages in the west half of the dam, which had already been constructed.

The removal of the timbers and rock and clay fill in cofferdam No. 1 was done with an Erie steam shovel, type 8, caterpillar traction, using a ½-cubic yard bucket.

This dam was built by the Dixie Construction Company. O. G. Thurlow was chief engineer for the Alabama Power Company and the Dixie Construction Company, L. V. Branch was resident engineer and H. L. Myer was construction superintendent for the Dixie Construction Company, of which the writer was principal assistant engineer.

Power for Electric Public Utilities

Information has recently been made public by the Geological Survey concerning the use of fuel in producing electricity during the past four years. The figures given show that public utility power plants produced more electricity in 1922 than ever before and that more than one-third of this was generated at water power plants, thereby conserving over 20,000,000 tons of coal. One-fifth of the total amount of electricity produced by water power in the United States is produced by the California hydro-electric plants.

Pennsylvania's Highway Program

The Pennsylvania State Department of Highways announces that its construction program for 1923-1924 includes building 275 miles of durable highway, which will exhaust all funds available for construction purposes unless the

voters in November authorize a $50,000,000 bond issue. The amount otherwise available, including $5,000,000 Federal aid, $4,000,000 motor license fund, is about $15,000,000. It is not considered desirable, however, to use the motor license fund for anything but maintenance.

Construction will be confined to primary highways, selected after a careful study of the relative needs and merits of the individual cases, including results of traffic surveys. Naturally, many will be disappointed by the omission of certain roads from the program, but "no change will be made in the program as now announced by the Department."

Automobile Costs in St. Louis

Purchase money and the gasoline bills are not the only expenses that automobiles run up against city governments. At the council meeting on June 26 of St. Louis, Missouri, ordinances were passed appropriating money for paying damages to a woman run over by an automobile belonging to the police department, an employee of the city who broke his wrist cranking a city truck, and a private automobilist who ran over a bank which was not protected by warning signs.

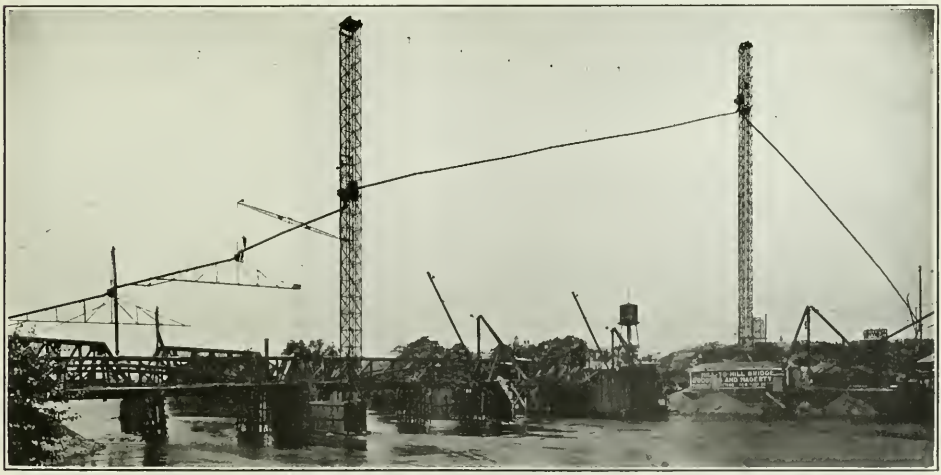
The fourth damage for which the city paid was incurred in a most unusual way. To quote from the ordinance: "On or about February 5, 1923, John Tayon was crossing the Compton Avenue viaduct from the north in his automobile and he had gotten a little more than half-way across when the blocks in said roadbed, due to expansion, rose up under said machine, causing the same to swerve and turn over; and by reason of said accident the machine of the said John Tayon was damaged in the amount of $64.75."

Hill-to-Hill Bridge

Description of operations employed in constructing a viaduct the design of which was described in the July issue. Deep foundations encountered great quantities of water. Construction equipment costing $300,000 includes two concrete mixing plants and hoisting towers and chutes.

By Frank W. Skinner

Work on the substructure was commenced in September, 1921, with the excavation for the pier foundations, which were carried through an average depth of about 10 feet of loam, 10 or 15 feet of gravel, and the remainder of the distance through disintegrated rock. About three-fourths of the material was removed by 1-yard orange-peel buckets operated by stiff-leg derricks with 60-foot booms set to command the whole area of each excavation. The spoil was delivered to 5-yard motor trucks and stored to use for backfill and to fill in between the spandrel walls of the bridge. The average haul was about ½-mile to a spoil bank located on a 5-acre lot rented on Sand Island, where it was piled to a height of about 30 feet and was reclaimed by a ⅞-yard steam shovel that loaded it into 38 x 11-foot wooden scale pans 20 inches deep that were hauled to the bridge, hoisted by traveling derricks with heavy steel I-beam sills



HOISTING AND DISTRIBUTING TOWERS CONNECTED BY SUSPENDED CHUTE SERVING ONE OF TWO DUPLICATE MIXING PLANTS

on tracks on the tops of the finished spandrel walls. The material was dumped in position, levelled in 12-inch layers, thoroughly wet down with a hose and tamped by ten-man gangs who handled about 250 yards per day.

COFFERDAMS

The gravel bed was thoroughly saturated with ground water, which flowed in great quantities into the deeper excavations, about one-half of which were sheeted with 14-inch arch-web Lackawanna steel sheet piles from 40 to 45 feet long, which were set up to make complete cofferdams of 35 x 75-feet maximum dimensions and were driven two or three feet at a time successively by steam hammers, suspended from derrick booms.

The excavation was carried on simultaneously with the pile driving and great care was taken to undermine and remove interfering boulders. Whenever the latter were encountered, driving was omitted at that point until the boulder was removed so that the piles were with little injury driven down at a rate equivalent to 10 to 20 piles per day. Considerable handwork was required for the excavation and was always necessary while removing the last two feet at the bottom and for cleaning and preparing the surface of the rock.

The material excavated from the river cofferdams was dumped outside to form an embankment which protected the cofferdam and provided fine material that filtered into the pile joints making them very tight so that there was practically no leakage, except through the bottom of the pit where the water boiled up in great quantities and was removed by two 8-inch and one 6-inch centrifugal electrically driven pumps, of which one was generally in reserve.

The contractor was required to make the excavation large enough to afford a clearance of two feet around all sides of the pier to provide for final inspection of the concrete—a feature that was omitted at the last pier after all of the first had been found entirely acceptable, developing no faults when inspected.

The piles, which had a penetration of about 30 feet, were pulled at the rate of twenty per day by the McKiernan-Terry hammer which drove them and were reclaimed in good condition suitable for repeated use. Before pulling them, the embankment that had been placed around the exterior of the river cofferdam was dredged up and deposited inside the cofferdam for backfill around the piers.

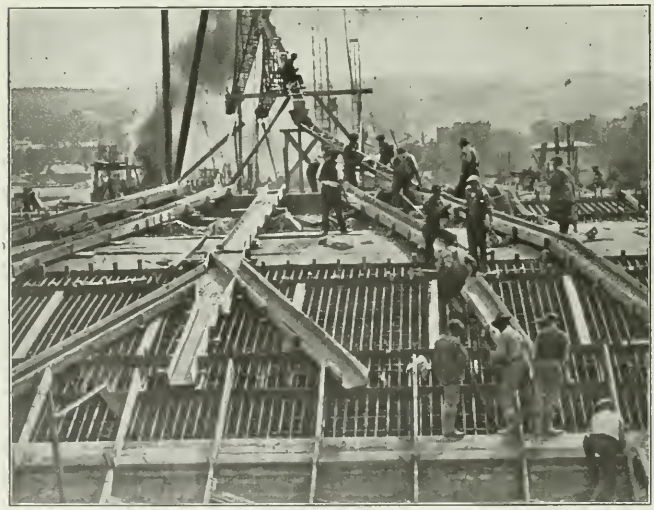
FOUNDATION PILES

The concrete piles for the foundation of Pier 2 were provided with castiron points and were driven by a steam hammer weighing 7,000 pounds and striking about 60 blows per minute on a cushion which endured for about two hours of steady driving.

The piles usually penetrated the first 15 feet in about 15 minutes and then, when they went down continuously without encountering special obstacles, penetrated at the rate of about 1 foot for 300 blows and were driven to a refusal of 50 blows for the last half-inch penetration. About 25 per cent of the piles penetrated the full distance without special interruption from encountering obstacles. When obstacles were encountered, a refusal of 100 blows for the last ½-inch penetration was required.

The tops of the piles were cut off when necessary, as was the case in most instances, by a pneumatic hammer scoring a channel around the four sides and exposing the reinforcement rods which were cut through with an oxy-acetylene flame, after which the core was easily wedged off, the work being done by two men at an average rate of about 3 hours per pile.

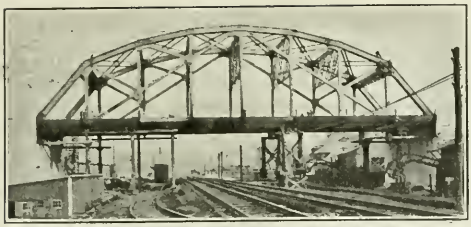
The wooden pile foundation for the steel viaduct and the pile foundations for the arch centerings for the river spans required about 750 piles from 30 to 35 feet long, which were driven by steam hammers suspended from the boom of a traveling derrick that set the pile caps and was followed by a traveller erecting the false work on them.



SPOUTING CONCRETE TO ARCH RINGS THROUGH MULTIPLE CHUTES.

AGGREGATE AND CEMENT

All of the concrete materials were of high grade and the broken stone was exceptionally uniform, hard and sharp. Most of it was obtained from a limestone quarry, 1½ miles from the bridge site, which was leased and operated by the contractor. Earth, about 3 feet in thickness, was stripped from the surface of the rock by a scraper and a vertical face 60 feet high and 200 feet long was operated with a level floor from 40 to 100 feet wide. The dip of the strata inclined about 60 degrees to the horizontal and the strata were from 1 to 4 feet thick. Full depth holes.



179-FOOT SPANS 1-2 AND 8-9

6 inches in diameter and 15 feet apart in both directions, were drilled to a maximum depth of 70 feet and charged with 60 per cent dynamite. A blast consisting of 16 holes produced about 18,000 tons of rock ready for the crusher. The rock was broken by the initial blast, small enough to be handled by a 1-yard steam shovel that loaded skips, was hauled up a 250-foot incline and dumped into the 24 x 36-inch jaws of a Bulldog rock crusher, from which it was elevated to a scalping screen and the rejects passed through a No. 6 and a No. 3 gyratory crusher. The screenings were sold to a manufacturer of concrete bricks and the broken stone was delivered to the bridge site by 5-ton automobile trucks that dumped into two storage bins each of 600 tons capacity. Except the steam shovel, all of the quarry plant was operated by electricity and required a force of 28 men.

Sand was delivered by rail and stored in two 300-ton bins adjacent to the stone bins, one of each being near each of the two concrete mixing and hoisting plants.

Cement was hauled 12 miles from the Pennsylvania Cement Company's mills at Bath, Pa., in 5-ton automobile trucks, and was stored in two houses, each of 7,000 bags capacity.

CONCRETE PLANTS

At each concrete plant there were two 1-yard mixers supplied by gravity from a receiving hopper that was filled with stone and sand by a 1¾-yard orange-peel bucket, operated by a 75-foot derrick boom. The aggregate and cement were placed in a 1-yard measuring box with horizontal marks to show the different levels for sand and stone for 1:3:5 mix. When other proportions of concrete were required, core boxes, each of 1-cubic-foot capacity, were nailed inside the measuring box until the required volumes were procured, thus providing for quick changes and accurate measurement for the various classes of construction.

The concrete mixers were operated at 20 revolutions per minute and were set with locked mechanism to run at least 2 minutes and were provided with an accurately measured quantity of water which varied in amount according to the instructions of the inspecting engineer.

The mixers were located about 1000 feet apart so as to command all of the main structure between them and for about 700 feet radius on each side. Beyond these points the concrete for the ramps and main bridge was delivered in buckets hauled on service tracks, or in some cases delivered to trucks and unloaded into elevated receiving hoppers, from which it was spouted a short distance to required position. The receiving hoppers were shifted from place to place as required, until all of the concrete within the radius of their chute had been deposited.

Adjacent to each mixer there was a steel hoisting tower, one of them 240 feet and the other 200 feet high. About 350 feet from the 200-foot tower there was erected in the river a 160-foot auxiliary tower carrying a boom with two suspended cantilever trusses. Steel cables, from the tops of the hoisting towers to the mast and auxiliary tower, supported steel chutes delivering to chutes on the cantilever trusses, thus providing a long radius of distribution.

(To be continued)

Redressed Granite Block in Philadelphia

Of about $6,000,000 worth of paving work completed in Philadelphia last year, the unprecedented use of redressed granite block was said by Julius Adler, deputy chief of highways, to have easily been the outstanding feature. Of 39 miles of repaving completed in 1921, approximately 27 miles was redressed granite block, and approximately the same amount and proportion held good in 1922.

Some changes in the specifications for this work have been made during the past few years. For example, in some of the earlier work the contractor was required to make good any deficiencies in granite blocks which might exist at the end of a contract, which requirement was open to the criticism that none but the most experienced could make even an approximate estimate as to what this shortage was likely to be. On later contracts the city has undertaken to supply any deficiencies in blocks that might arise, the contractor hauling them from specified points, and this limited the uncertain element of the contract to the cost of hauling . The 1922 contracts provided for payment of the cost of hauling as well.

With these uncertainties eliminated, the greatest one remaining was variation in the quality and character of the old block in the street. It has not yet been found possible to so draw the specifications as to make the work of redressing granite blocks identical on any two jobs. The reason for this is that the blocks have been obtained from various localities and quarries and have been in service for periods varying from 10 to 40 years, some on heavily traveled streets and others on residential streets. As the specifications described a uniform product to be obtained from these non-uniform blocks, the work required on one job may be much greater than that on another. Block which has cobbled badly under wear requires more labor in dressing, more replacements under inspection and more grout because the joints are more open. For this reason contractors bidding on this class of work should carefully examine the character and condition of the existing old blocks in the street to be repaved.

In general, the city expects to obtain from each class of block pavement a pavement of redressed block that will meet standard specifications. Occasionally, however, it is found impossible, after a thorough trial with skilled dressers, to produce the specified block of approximate rectangular shape rather than lose the potential value which the city has in the old blocks and be required to furnish new ones, a treatment of the blocks is then agreed upon which will produce the best possible block with the destruction of the least number.

Another feature in which more or less latitude is necessary is in the depth of block, this latitude being permitted with a view to reducing waste of blocks and unnecessary labor in cutting them. Measurements made on a number of streets in the city have shown that the old blocks may vary from 9 to 14 inches in length and frequently more within a single city block. The specifications provide for one-inch permissible variation in the depth of the redressed blocks, which correspond to two inches in the length of the whole blocks. It is readily seen that blocks with irregular depth will not preserve an even surface under the pounding of heavy traffic on a sand-cement bed which has not set up, where a mastic or soft filler is used, and the same is true if a cement grout filler is used except that the blocks, instead of gradually assuming an irregular surface as the filler softens, are punched down by the heavy traffic as the grout filler is shattered. This disadvantage of unequal depth must be balanced against the additional cost or impractibility of securing uniform depth from the old blocks and a practical average struck between them.

Cleaning Sewer Mains

Methods and appliances used by the city engineers of cities in eight states, results obtained, cost, and other details, described by them especially for this symposium.

Learning from the questionnaires submitted to city engineers during June that a number of them were using mechanical appliances of different kinds for cleaning sewers, we wrote to such engineers asking that they inform us further concerning their methods and results of using such equipment, giving details in as much fullness as their records permitted. Replies have been received from a few, some using one type of equipment and some another, and all finding much advantage in each of them under conditions suitable to it. W. P. Cottingham, city engineer of Gary, Indiana, describes the use of the Kuhlman sewer cleaning apparatus; S. Cameron Corson, who is borough engineer of Norristown, Pa., describes the use of the Stewart sewer cleaning machine; Ivan E. Houk, city engineer of Dayton, Ohio, describes very fully the use of the turbine cleaning machine, which also is used by G. H. Randall, city engineer of Oshkosh, Wis.; while use of the Victory self-propelling nozzle is described briefly by G. H. Atchley, city engineer of Tucson, Ariz., L. S. Thorpe, city engineer of Bozman, Mont., George A. Carpenter, city engineer of Pawtucket, R. I., R. M. Evans, city engineer of Clairton, Pa., and R. M. Fulweiler, city engineer of Beaumont, Tex.

With the abundance of information furnished by these engineers it has been necessary to condense some of their descriptions, but in doing so we have endeavored to retain all of the important facts communicated by them and bearing directly upon this subject.

Sewer Cleaning in Norristown

By S. Cameron Corson*

For many years our only method of sewer cleaning was by the use of rods screwed together. At times the workmen would lose these rods by turning them in the wrong direction and a rod is now used with a lock joint which is a great improvement. These joints will stand any pressure or twisting, but the wood from which they are made must be absolutely free from knots or flaws.

The following appliances are used by the sewer cleaning gang: 400 feet of rods with improved lock joint and special attachments such as a claw for entangling rags or other materials, a spade for cutting roots or materials attached to the sewer, a spiral screw 4 or 5 inches in diameter and 6 to 8 inches long to bore into substances for drawing them out, and a spear for making a hole through a bunch of roots or other materials that obstruct the sewer. When a spear has been forced through the obstruction to the next manhole a cable is attached to the last rod and drawn through and up to the street. A windlass is placed over each of the two manholes carrying a cable sufficiently long to reach the other manhole, and by means of these a series of buckets of diameters varying from 8 inches to 15 inches, with knife-like edges front

*Borough Engineer, Norristown, Pa.

and rear, are drawn through the sewer. These cut off the roots at the top and bottom and they enter the bucket through the shutter in the front of it. Dirt, sand and other materials also are picked up by the bucket, the shutter being closed when the bucket is drawn back. To facilitate thorough cleaning we have a line of hose connected to the nearest fire hydrant carrying a small stream into the sewer. This operation requires two men at the top of each manhole and one at the bottom of the manhole to which the bucket is drawn when being removed. An auxiliary windlass with a line attached is stationed at this manhole and the bucket is raised to the surface by this means. The machine used by us is known as the Stewart sewer cleaning machine.

At the completion of the operation, to insure ourselves that the sewer is clean, particularly along the top of the pipe, a ray of sunlight is thrown through the sewer by the use of mirrors from either end.

The men in the sewer cleaning gang receive wages varying from 60 to 45 cents per hour and the cart 75 cents, a total of about $3.25 per hour. A sewer clogged for a distance of from 10 to 50 feet can be cleaned thoroughly in about five hours elapsed time at a cost of $16.25, or an average length of 30 feet at about 50 or 55 cents a foot. It sometimes happens that all of that time will be required and even more to clean out one obstruction 8 or 10 feet long. The amount of material removed varies from a few cubic feet to a full cart load or more. We have raised two root masses 8 and 10 feet long respectively and nearly the full diameter of the pipe. In every case, however, there has been an open space on the flow line of the pipe.

The amount of material removed is not known, as we rarely keep an account of it, but we do examine it thoroughly to ascertain the cause of the clogging in order to prevent a recurrence, if from house wastes, etc. If tree roots cause the stoppage, however, there is no remedy but to cut down the trees. In my experience the worst enemies to sewers are North Carolina poplars, swamp willows and like trees whose roots require a great deal of moisture. In some cases sewers have been clogged so completely that it was necessary to dig down to them and break out a section, and in such cases we have found dense masses of roots which had grown from a tiny root that had penetrated a very small crack in the cement joint.

Manholes on sewers should not be over 200 feet apart, as even at that distance it is difficult for a good strong man to force the rods through the obstruction.

A complete outfit should be used in every municipality. The usual cost is from $1,500 to $1,800 and if a cutting machine is desired it will cost $500 more. We have saved enough in one year to pay for our machine, with some to spare. Before we purchased the outfit, men cleaning by hand rodding often consumed from several days to a week to clean an obstruction 10 to 50 feet long, which now requires only a few hours.

Cleaning Sewers in Gary, Indiana

By W. P. Cottingham, City Engineer

A large part of Gary's 90 miles of sewers, which operate on the combined system and range in size from 96 inches to 10 inches, must be cleaned at more or less regular intervals. This condition arises from the fact that a considerable part of the sewers were laid in water-bearing sand when speedy construction was demanded and there was little realization of the necessity for tight joints. Sizes below 30 inches are made of vitrified clay pipe.

The material removed is mostly sand, which has no objectionable odor and is deposited in fills without creating a nuisance. The removal is accomplished by the Kuhlman sewer cleaning apparatus. It has been found that the sand does

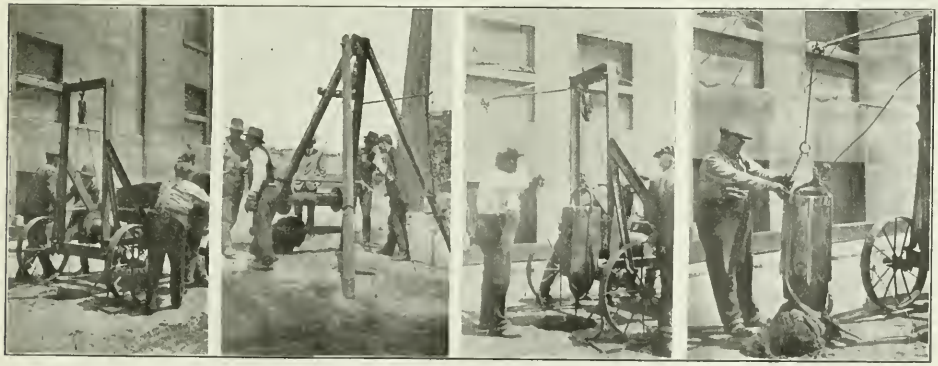


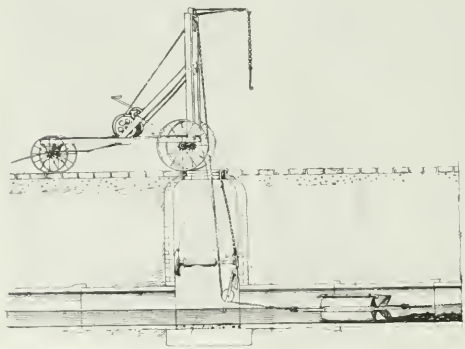
Fig. 1—Portable windlass. Fig. 2—"A" frame rig. Fig. 3—Loaded bucket rising from manhole. Fig. 4—Discharging load.

SEWER CLEANING AT GARY, INDIANA.

not carry any considerable distance after entering the sewers, except during storm flows. Therefore the greater amount of sand is removed from the lateral sewers unless it has been flushed to the main sewer by use of flushing nozzles connected to fire hydrants. The present practice is along this latter line and the results appear to be most satisfactory. At the end of this season a statement of comparative costs will indicate which method is most economical and which best prevents excessive accumulation of sand in the sewers at points where stoppage may occur unless removed.

Two outfits are employed, each gang using a complete setup of sewer-cleaning apparatus, which consists of two windlass riggings with cable, buckets and manhole jacks of special design to carry the cable into the sewer. The photograph shows two machines working on a 48-inch main sewer with manholes spaced 330 feet apart. The A frame rigging shown in Fig. 2 can be used to good advantage when it is necessary to work several days at one setup, but is not convenient for use on the smaller sewers where it is necessary to move two or three times each week.

The first step in cleaning a sewer is to float a line through or shove a sewer rod through, by which a cable is drawn from one manhole to another. A bucket is hooked between cables from the windlasses at the two manholes, this bucket being made of steel plates and equipped with hinged jaws which are operated by two side plates controlled by a bail hinged at each end. These two end bails also serve to expand the bucket while it is being emptied of its load. The jaws of the bucket are the cutting edges and are closed when the pull on the bucket is reversed. The manhole jack, which guides the cable into the sewer, is an essential feature and insures quick manipulation of the buckets into and out of the sewer. It consists of a yoke with ball joint adjusting screws with a wedge connection on the opposite end, and a trolley arm with cable wheel pivoted at the yoke extending downward and guiding the cable while the bucket is in the sewer. When the bucket is being removed from the sewer it strikes this arm, which swings upward and guides the bucket to the center of the manhole and prevents it striking against the junction of the manhole and the sewer.



SEWER-CLEANING APPARATUS USED AT GARY, IND.

When the bucket is drawn into the sewer by windlass, the tension on the cable indicates when a load has been obtained and the pull is then reversed and the bucket withdrawn. By taking the load off the hinged bail, the jaws open and the bucket discharges its load. Various sizes of buckets are used, a 6-inch being usually used to start operations in a 12-inch line, with an 8-inch bucket for finishing. As the work progresses the bucket is passed full length of the sewer in each direction, picking up a full load each way.

Four men make up a gang on lateral sewers and will clean a section, move, and make the next setup in from a day and a half to two days. On the larger sewers—42-inch to 84-inch—an 8-man gang is used, pulling buckets of 12 inches diameter carrying approximately 1¾-cubic feet. During the past few months such a gang has spent from 20 to 25 days cleaning a section, removing approximately 50 cubic yards of sand from 330 feet of sewer. The accompanying photographs were taken on this work four days after starting.

The cost per foot of such work is not obtainable for the reason that comparative figures were not considered essential during the past few years. The total cost last year to the city of Gary for sewer-cleaning operations amounted to $12,000, some of which was for cleaning catch-basins and gutter inlets, some for flushing sewers, and the larger portion for the continuous operation of the gangs with the machines.

In practice, a gang starts at the upstream end of a lateral sewer and if inspection shows a small deposit, they will flush a section or two using a bag dam in a manhole to collect the sand. When a section is found showing a considerable sand deposit, the machine is used. Very often this will be in a section where the repair gang had previously found and repaired some leaky joints. Each section between this one and the main sewer will be cleaned out in turn. Some of the lateral sewers require such cleaning twice a year, some every two years. The main sewer in the district affected requires cleaning every year.

Cleaning in Oshkosh

The city engineer of Oshkosh, Wisconsin, G. H. Randall, informs us that that city uses the "Turbine" sewer cleaner, which "cost $1,500 a few years ago and saved us twice that in one season. The cost of operation is difficult to state, as it might depend on the size of the sewer, the amount of matter, the length of time since the previous cleaning and other factors. Three or four men can operate it, this including getting the rods and cables into the sewer. They can clean about two blocks or 800 feet in one day if the pipe is not larger than 15 inches. A 24-inch sewer that was two-thirds full of mud,

gravel and roots was cleaned for a length of 400 feet in two days. This sewer would in a short time have been in such a condition that it would have been necessary to take it up and repair it at a cost of several thousand dollars." Mr. Randall has also found the Petersen hydraulic flusher "a very good cleaner for a very small sum of money."

Other Reports

Pawtucket, Rhode Island—George A. Carpenter, city engineer, writes that his city employs a maintenance gang with a light Ford truck containing the equipment, which is at work practically all the time. They use jointed rods, a Victory self-propelling nozzle on the end of a hose line attached to a hydrant, and a Stewart cleaning machine. "We find all these effective in the particular work for which they are adapted. We find that the Victory self-propelling nozzle will cut its way through catch-basin connections that have become filled with sand and gravel, where the jointed rod would be of no use."

Clairton, Pennsylvania—The only apparatus used is a self-propelling nozzle working with 70 to 90 pounds water pressure, and the ordinary 3-foot extension rods. There have been few obstructions. Three men are used, common laborers at about 30 cents an hour. One or two of the jobs have required two or three days, but usually the sewer has been opened in an hour or two. The sewers in Clairton are largely combined sewers of sizes ample to carry away flood water, excepting at one or two locations.

Beaumont, Texas—The topography of Beaumont is very flat and most of the sewers are laid on a grade of .2 of 1 per cent., while in exceptional cases 8-inch pipe has been laid on .15 and .10 per cent. Flush tanks are not used. The stoppages are in nearly all cases due to rags or other foreign matters. Our informant, City Engineer R. M. Fulweiler, states that these grades are known to be flatter than the best engineering practice, but stoppages in them are found to be due either to the breaking of the pipes under streets carrying tracks or roots of trees where the pipes were improperly laid, or to rags or sticks which will cause stoppage on almost any grade.

In cleaning the sewers, the city uses a self-propelling nozzle attached to a 2½-inch fire hose with 40 pounds water pressure, which will travel for a distance of 300 feet in a sewer of from 6 to 12 inches diameter and clean it thoroughly of silt or sediment. This is attached to second-hand fire hose carried on a hose reel and is handled by one of the ditching crews, "as it takes more than our two men in the sewer force to handle this hose out of the way of traffic." The city has little occastion for using the apparatus, however.

Last year there were six or eight bad stoppages which necessitated digging up the sewer. In each case stoppage was in a connection from a catch-basin into a combined sewer in which a piece of wood or of carpet or some other foreign matter had lodged. In one instance a block of wood 2x7x14 inches was taken from a 12-inch pipe.

Tucson, Arizona—City Engineer G. H. Atchley writes that they use rods and a self-propelling nozzle. A man hired by the year at $4.00 per day looks after the flush-tanks and cleans the sewers when stoppages occur, aided by a helper at $2.50 per day when necessary. The principal difficulty encountered is due to sand and dirt which blocks the sewer occasionally, and two or three times a year trouble is experienced from roots, but it has not been necessary to dig up a sewer for seven or eight years, the rods and nozzle being all that was needed. "We have found that it pays to keep the sewers under continuous inspection and correct minor troubles before they become major difficulties."

Bozeman, Montana—City Engineer L. S. Thorpe states that they have no special methods but simply get a float through the sewer with a light rope attached to it and with this draw through a 3/8-inch flexible steel cable, by which cable one or more steel brushes are drawn through the sewer, a geared windlass being used for this purpose. Most of the equipment was constructed locally. The city has also used a self-propelling nozzle with good success in its storm sewers.

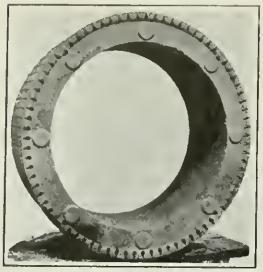
The next issue will contain a description of "Sewer Maintenance in Dayton," in which City Engineer Ivan E. Houk describes cleaning by flushing, by use of the turbine machine, buckets, and other methods.

Concrete Wells in Holland, Michigan

In its annual retort for the year 1922, the Board of Public Works of Holland, Michigan, gives prominent place to a description of a new well that was built during 1922, from which description we have condensed the following:

The well was carried to a depth of 72 feet, although it had been intended to carry it to 135 feet but a thick layer of large boulders prevented going deeper. The well is built of concrete pipe from the surface of the ground to the bottom, the inner diameter being 25 inches and the outer diameter 32 inches. The bottom part of this, as in the case of steel well lining, is composed of strainer sections for admitting the water. These strainer sections are about 12½ inches long and have vertical keystone-shaped grooves cast in the outer surface. Water flows into the grooves and thence down to the bottom of the section and into the well. The sections are held apart approximately 3/32 of an inch by means of bosses cast on the ends of the sections.

In building the well, a temporary steel casing was first driven the entire depth and the material removed from within it by an orange-peel bucket. A concrete block or plug was then lowered to the bottom by means of four steel cables that were fastened to it. The strainer sections were then lowered into place, being threaded over the four steel cables which passed through vertical holes cast at the quarter points of each section. Following the strainer sections,



CONCRETE STRAINER SECTION.

the plain pipe sections were threaded over the four steel cables and lowered into place. The annular space of about 5 inches between the strainer sections and the steel casing was then filled with gravel to the top of the strainer sections and with clay for the rest of the distance, and the steel casing was withdrawn during the filling.

A 24-hour test was made of this well on April 15th at a continuous rate of 2,000 gallons per minute, the maximum capacity of the motor and pump available. During the first 8 hours the water level in the well lowered continuously but remained constant thereafter, the water falling to a depth of 32 feet below the original level. The suction line to the existing tubular wells was extended to this well and the entire supply drawn from it. In November an American Well Works deep well, 3-stage centrifugal pump was installed, driven by a vertical 100-horsepower Westinghouse slip ring motor with a capacity of 1,200 to 1,500 gallons per minute. The pump is provided with remote control apparatus and is operated entirely from the station. The cost of the well, including the test, was $4,728. The cost of the deep well pump, including the remote control panel and power wiring, was $4,570.

Carrying Dragline Across Bayou

In connection with constructing about 20 miles of embankment for the Farelly Lake Levee District in Arkansas, the contractor, Reeve H. Hutchinson of Gillette, found it necessary to carry the machine across a bayou 200 feet wide and 35 feet deep. As the dragline weighed 300,000 pounds, considerable thought was given to obtaining a substantial roadway. The solution adopted by the contractor was a trestle built of 50-foot cypress piles driven five piles to the bent in two rows of bents 24 feet apart, center to center. This constituted two trestles, one for carrying each caterpillar tractor of the dragline. Each bent was capped with a 12″x12″x12′ oak timber, and upon these caps were placed four lines of 12″x12″x12′ oak timbers, spaced 4 inches apart and extending the full length of the bridge. The bents were placed 12 feet apart along the line of the trestle, corresponding to the 12-foot length of the stringers. The two lines of trestle were tied together with oak sway bracing for about one hundred feet in the center of the bayou.

After the bridge had been used for carrying the dragline across the stream, it was continued in use, one side to serve as a wagon road and the other to carry a standard gauge railroad over which material and machinery was carried for construction of a flood gate.

By means of this dragline and another like it, the contractor constructed a levee containing about 1½ million cubic yards of earth, all of which was taken from the river side of the embankment. The slopes of the embankment are three to one on both sides with a top width of one foot and a net height of 16 to 20 feet. Most of the work was through virgin timber, through which was cleared a 300-foot right of way. All stumps were blasted and grubbed and removed from the ground to be occupied by the fill, the surface of which was plowed to insure against seepage under the embankment.

Rendering Polluted Oysters Safe

A plant is operated at Inwood, L. I., for sterilizing oysters by which 15,000 bushels of oysters were prepared for market last season with the approval of Federal authorities and the New York State Conservation Commission. The plant consists of two concrete basins, each 22x25 ft. and 18 in. deep and capable of handling 200 bushels of oysters. A pump with capacity of 125 gallons a minute delivers into the basins water from a trench filled by percolation from Jamaica Bay, its salinity being 1.021. A portion of the water pumped passes through an electrolytic and returns to the pump suction where it is mixed with the other water. Electrolysis of the sea water produces hypochlorite of sodium, a sterilizing agent which is thus brought into contact with the oysters but does not touch the meat of them and therefore the dose can be made stronger than is possible in sterilizing water. The Commission imposes severe restrictions as to qualifications of operators and degree of pollution of oysters treated. The process as carried out gives a large factor of safety, so that minor variations from theoretically optimum methods and conditions may occur without impairing the effectiveness of the treatment.

MOVING DRAGLINE ACROSS BAYOU ON DOUBLE TRESTLE.

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Maintaining Sewerage Systems

While much appears in both periodical literature and text books concerning the designing and constructing of sewerage systems, little is to be found concerning the operating of them; and yet intelligent and continuous supervision and maintenance are necessary to satisfactory service. We therefore believe that unusual interest will be taken by city engineers, and others having charge of sewerage systems, in the series of articles and short descriptions dealing with sewer cleaning and other maintenance methods, the first instalment of which appears in this issue.

In the July issue we published, under the heading "Labor-Saving Devices," a list of the devices used for cleaning sewers in a considerable number of cities. The engineers of a number of these cities have kindly supplemented the questionnaire answers therein tabulated by descriptions, some brief and some extended, of the methods employed by them and the results obtained, the costs and other details.

As is only natural, different engineers have reached different conclusions as to the most satisfactory methods and appliances. This may be explained partly by the variations in conditions to be met. In some cities the greatest trouble is due to sand entering the sewers and deposited there; in others, to roots; in still others (generally combined sewers), to sticks and other large objects; while some with flat grades are continuously accumulating deposits of sewage matter.

Another probable explanation is the meagre opportunity the engineers of different cities have for learning the methods used by each other, and therefore the limitation of their knowledge of the subject to that obtained by their own experiences. It is to be hoped that the accounts we are now publishing will be followed by others on this subject, and we urge those who have any helpful experiences or ideas to send them to us for publication.

Forethought in Public Work

It is gratifying to us, after having frequently urged in our editorial columns that plans be started months in advance for public works of importance in order to permit adequate preparation of plans and full advantage of the construction season, to find public works authorities beginning to realize the importance of this and act accordingly. One illustration is furnished by the Street Cleaning Department of New York City, which on May 24th had already begun making plans for handling the snowfall of next winter. On that date Street Cleaning Commissioner Alfred A. Taylor, and John J. Condon, in charge of snow removal, informed the Street Cleaning and Paving Committee of the Fifth Avenue Association that plans were being made for handling next winter's snow, taking advantage of methods that had proven beneficial but introducing a number of improvements suggested by past experience. The Commissioner had already ordered $1,300,000 worth of new equipment for the work.

Other illustrations may be found in several of the state highway departments, especially those where appropriations are made biennially, thus permitting plans to be made and contracts awarded well in advance for at least the second year of the biennium, even though the necessary legislation may not be decided upon sufficiently early for the first year.

Evidence of a more or less general taking of forethought in public work and consequent spread of construction throughout the year is found in the fact that never before this year have cement and other construction materials been delivered in such quantities in the early spring and even late winter.

It is to be hoped that the practice will become general, until it can not be said that any work, or purchase and delivery of material, is delayed beyond the most advantageous date by procrastinated legislation, planning or awarding of contracts.

Fellowships in Highway Engineering

Four fellowships in highway engineering and transport will be awarded by the Board of Regents of the University of Michigan, two not later than September 10th and two not later than November 1st. These provide for investigation of subjects relative to highway transport, to hard surface pavements and to moderate-cost country roads. Each pays the sum of $250 with an allowance of $50 for expenses, and the holders do not have to pay tuition fees. They must hold Bachelors' degrees and enroll as a graduate student and candidate for the degree of Master of Science, and must be in residence either from October to February, from December to March, or from February to June. Applications can be made to Prof. Arthur H. Blanchard at the University of Michigan.

Pennsylvania Highway Police

The Department of Highways of Pennsylvania has asked the superintendent of the State Police to organize a "Department of Highways Police" to enforce the provisions of the motor laws. At first there will be 125 men. They will be mounted on motorcycles and wear a uniform that will permit them to be recognized instantly. They will receive $100 per month and expenses.

They will be trained at the State Police Training School, where they will be thoroughly instructed in the motor laws of the state and in the use of motorcycles. The force is expected to be on duty the latter part of August.

Boston's $3,500,000 Street Widening

The second week in June saw the beginning of the most important street improvement undertaken by Boston in recent years—the construction of a radial highway about two-thirds of a mile long, extending from Charles St. to Cornhill, formed by widening and straightening Charles and Court streets. The street will then be not less than 100 feet wide from end to end and have a maximum width of 155 feet. Slices will be taken from land and buildings, including banks and hotels, 130 pieces of land being affected. The entire cost will be about $3,500,000, but it is expected that about $1,000,000 will come back to the city in betterments.

Water Waste in Chicago

The Western Society of Engineers has prepared and submitted to city officials of Chicago a report on the water waste problem of that city, in which it states that three-fourths of the citizens suffer inadequate water service, although the outlay for new plants is increasing at 2½ times as rapid a rate in proportion to population growth as in other cities and operating expenditures overtook revenues eight years ago and today the operating deficit is $1,000,000 a year. This is due to waste—2 gallons are pumped for each gallon used. This also seriously curtails fire protection, thereby increasing insurance rates and the cost of sewage disposal, and makes it impracticable to secure an attractive, filtered water supply.

Elimination of waste will remedy these defects in the service, double the average pressure, reduce the cost, postpone for 25 years the construction of new cribs, tunnels and stations, and thereby secure a saving of $88,000,000 in construction costs and $145,000,000 in operating costs.

Michigan Highway Notes

In his 1922 report as state highway commissioner of Michigan, Frank F. Rogers deals briefly with a number of interesting features of the recent work of the highway department, of which the following brief notes have been made:

Practically all contracts for concrete pavement awarded during 1922 provided for a metal construction joint running lengthwise of the pavement. "This tends to define definitely the crack which usually is experienced down the center of concrete roads and also acts as a dividing line for traffic.

"The department has adopted a general policy of constructing one-course gravel roads on many of the trunk lines which are not heavily travelled at present, deeming it good policy to construct a larger mileage of this type of road and therefore serve a greater number of people than to construct a higher type of road of decreased mileage and therefore decreased service to the people in general."

BRIDGES—During the past two years the department has eliminated a great percentage of the steel bridges formerly in use by using concrete girder designs up to 90-foot spans. The designs adopted have curved top cords and bottom cord brackets. The 90-foot concrete girders have been tested and found exceptionally stiff and remarkably free from impact and vibration.

The department has paid more attention than formerly to bridge maintenance. The work done includes cleaning and scraping, painting, floor repairs, new floors, repairs to super-structures, riprapping, repairs to substructure, cleaning of channels at bridge site, and replacing and repairs of stringers. The department operates five 2-ton trucks on pneumatic tires with air spray painting outfits and small air tools, each under a competent foreman and crew of about three additional men. During the past two years it painted 118 bridges, placed new floors on 29 bridges and repaired floors and other portions of 59 others. At least 60 days is allowed between successive paintings and preferably a year, three coats of paint being applied where the steel is in a badly rusted condition, with a minimum of two coats otherwise. An average of over $40,000 a year has been spent in this work.

CLEANING UP ROADSIDES—It has been found that, in removing noxious weeds which the law requires shall be cut and destroyed, many shrubs and other attractive growths are destroyed indiscriminately, these including the wild rose, hawthorn and dogwood, which the department believes should generally be saved, as should even the sumach and elder and such vines as the wild grape and bittersweet.

Nurseries sell these for ornamental planting and yet thousands of dollars worth of them along the roadside are destroyed each year.

"In general, the shoulders, ditches and about two feet outside the ditches should be kept mowed. From there to the edge of the right-of-way all noxious weeds, dead brush and rubbish should be removed, but desirable shrubs and young trees should be saved and properly pruned."

Maintenance costs are given for the two years covered by the biennial report, for each of the several classes of roads in use. Reducing these to the average cost per mile, we find that during the year 1921-22 the costs were as follows: Earth, $268.57; stamp sand, $415.66; gravel, $666.94; waterbound macadam, $806.09; bituminous macadam, $525.95; bituminous concrete, $514.09; cement concrete, $829.81; brick, $133.36; unclassified, $512.34. The last item includes sections of road comprising more than one type of surface. The cost of concrete is unusually high, largely because the majority of these roads were originally built too narrow to carry present traffic and many have had to be widened and in some cases reconstructed, which cost has been charged to maintenance.

Cost of Concrete Pavement

J. H. Cahill gives the following figures for concrete surfacing performed by him in 1919 on a stretch of 6.38 miles of road beginning at the limits of Lexington, Kentucky. The average haul was 3.69 miles over a comparatively good macadam road with no grades over 3 per cent. Weather conditions were above the average and absolutely no delays were encountered because of slow delivery of material. The job comprised 67,373 square yards of plain concrete 18 feet wide, 6 inches thick on the sides and 8 inches in the center. Expansion joints were set only at the end of each day's run. The itemized costs were as follows:

24,053 bbls. cement @ $2.70 less 60 cts. for sacks and 5 cts. discount, credit taken for sacks returned; cost of handling and return freight added	$51,211.30
8,580 tons sand f. o. b. Louisville @ 80 cts.	6,864.00
15,875 tons gravel f. o. b. Louisville @ 80 cts.	12,700.00
1,620 ft. 9 in. expansion joint delivered at Lexington	193.20
Freight on 24,455 tons sand and gravel, Louisville to Lexington, @ 80 cts.	19,564.00
Unloading sand, gravel, cement	6,353.70
Drayage by contract 16½ cts. ton mile and extra trucking	17,194.00
Water line and pumping (labor laying, maintaining and pumping)	6,332.30
Mixing, placing and finishing concrete	17,675.80
Covering and watering (labor only, no charge for water)	5,021.65
Equipment 25% of actual cost, $21,167.93	5,274.20
Bond, liability and incidentals (pro rated)	7,846.90
Total	$156,431.05

The total averaged $2.32 per square yard. This does not include the cost of preparing the subgrade, as this was paid for separately and cost $6,624.60, or a fraction less than 10 cents per square yard.

Mr. Cahill has also made an estimate of what this work would cost today. Cement being a little more than 20 per cent higher net, sand and gravel 10 cents more per ton and freight 50 cents more, drayage 22 cents per ton-mile with most of the other items figured the same. This gives a total of $199,621.79, or an average of $2.90 per square yard, or 27½ per cent greater than in 1919.

Sod in Earth Road Construction

Not so many years ago road construction in the prairie states quite commonly consisted of digging sod from the sides and throwing it into the center of the road where it was more or less surfaced into a crown and left to do its worst to the traffic. The writer can remember when the same practice prevailed in the country sections of New York and other eastern states, where roads repaired in this way were for weeks in considerably worse condition than they had been before.

The "Service Bulletin" of the Iowa State Highway Commission states that this practice continued in Iowa until 1914, in which year blade-grader operators began the practice of throwing a thin coat of sod from the shoulder to the center of the road on the first trip and distributing it uniformly and then covering this with clean earth from the ditches and shoulders from which the sod had already been removed. This worked well in constructing the road where a crown had to be made, but in reshaping a road which was already crowned and a large part of which had grown up to grass except in a narrow travel way, it was not practicable to remove all of the sod and pile it in the middle of an already crowned road and then cover this with dirt.

According to the "Service Bulletin," during the past two or three years a blade-grader expert in the employ of the commission, O. M. Briley, has been working out a new system of handling the sod under these conditions. Mr. Briley has described the method of working as follows:

"No one general rule or method of procedure will apply to all roads and all conditions," says Mr. Briley. "Generally I find that one plan which I will describe, works satisfactorily in most cases when the crew goes out to rebuild or reshape an old road which has been previously put to permanent grade. The same system should apply to reshaping most of the roads which have been previously put to standard cross section only by the blade-grader.

"We find the stakes set by the engineers, usually in the bottom of the side ditch or where the side ditch is to be. I measure the width apart of the front grader wheels and then set a new line of stakes or move the old ones just the width of the grader wheels inside the first line up onto the shoulder of the road. With my stakes well up on the shoulder of the road I have a good, clear line to follow in making my first cut and usually a good footing for

both the engine and grader. I find this is a great help in making a good looking, straight shoulder line for my road grade.

"On the first cut, I set the outer edge of the blade as high as possible, sending the cutting point down so that it will gouge out a rather deep and narrow furrow. As I go I take out my entire new line of shoulder stakes. Material thrown out of this furrow frequently carries with it considerable grass and rubbish but seldom heavy sod. This, of course, goes toward the center of the road into more or less of a ridge but usually there is no difficulty in covering the material up in later operations. On my next trip around, the deep furrow forms a trench to guide and hold my left front wheel for the first heavy cut which usually gives me the shoulder line of the grade and the center line for the bottom of my side ditch. The furrow also provides the trench in which to throw the sod and grass that comes out on this second round.

"Usually one cut gives the lineup for my side ditch and shoulder and gets most of the grass and sod up into the trench. As this material comes off the blade it is usually turned sod side down into the bottom of the trench and left with a thin coating of fairly clean earth on top. I then make as many cuts as are necessary to open the side ditch properly, clean off the back slope and get the material needed to fill out and shape up the road grade in the customary manner. All this latter dirt is, of course, thrown on top of the sod and provides good, clean earth for finishing and working up the traffic surface.

"Occasionally when the traffic surface is badly weed grown a considerable distance out from the shoulders making too much grass and sod to throw toward the center when making the first trench cut described above, I make a thin cut on the first trip around, throwing the skimmed off sod and weeds out into the side ditch. The next trip around the trench is made and on the third trip, or the first trip made down the side ditch, the skimmed off sod and grass with additional material is thrown back on top of the road and into the trench. The building and shaping of the road grade is then continued as described above."

Truck Weights and Gasoline Taxes

Recent reports from most of the states show a spread of the idea of raising highway revenues by taxing gasoline; also that of setting a limit to the gross weight of motor vehicles, although there is no general uniformity in the limit set.

Thirty-three states now tax gasoline, and of these eleven levy a 2-cent tax and three others will advance the rate from 1 cent to 2 cents next January. In eighteen states the tax is now 1 cent; while in one state it is 2½ cents and in three states it is 3 cents.

The maximum gross weights allowed, according to the latest figures at hand, are: 12,000 pounds in New Mexico; 12,500 pounds in Vermont; 15,000 pounds in North Carolina; 16,000 pounds in Colorado and Florida; 20,000 pounds in Alabama, Iowa, Maine, Maryland, New Hampshire, Ohio, South Dakota, Tennessee, Utah and Virginia; 22,000 pounds in Delaware, Oregon and Texas; 24,000 pounds in Indiana and Washington; 25,000 pounds in Connecticut, Nevada and Wyoming; 26,000 pounds in Pennsylvania; 28,000 pounds in Minnesota and New York; 30,000 pounds in California, and 32,000 pounds in Illinois.

As the motor vehicle manufacturers of the country are said to be almost unanimous in the opinion that the 3 or 3½-ton truck is the most economical unit, with the 5-ton as the economical limit, it seems probable that the states will agree on 20,000 to 25,000 as a universal standard.

Iowa Board of Engineering Examiners

The Iowa State Board of Engineering Examiners is now organized with the following membership: Seth Dean, Chairman, address Glenwood, Ia.; L. M. Martin, Vice-Chairman, address Atlantic, Ia.; Alvin LeVan, address Des Moines, Ia.; B. F. Fleming, address Iowa City, Ia.; C. S. Nickols, address Ames, Iowa.

All correspondence or business matters for the Board should be addressed to W. C. Merckins, Secretary, State House, Des Moines, Iowa.

Street and Highway Statistics

Replies to questionnaires, supplementing the tables published in the February, March and April issues of Public Works. Amounts of city paving and highway improvement done in 1922 and contemplated in 1923

Statistics obtained by us from officials of several hundred cities relative to the amount and cost of street pavement laid during 1922 were tabulated and published by us in the issues of February and March, and those relative to county and state roads improved during 1922 and also work contemplated for 1923 were published in the April issue. Since the tabulation of these replies, others have been received, and are given in the tables following.

In addition to these tables, others are given that were crowded out of the previous issues by lack of space, these giving information concerning "Municipal Repair Plants," "Waterbound Macadam and Gravel Pavements and Cement Sidewalks," and "Reinforcement and Resurfacing" of county roads.

In the last table is shown a great variety of kinds and weights of reinforcement, although the influence of state highway standards is shown by uniformity among the cities of a given state, as in Illinois, Iowa and New York. The present tendency seems to be toward the development of standards of weight throughout the country.

Municipal Repair Plants

Replies to the questions: "Have you a municipal plant used for repairing pavements?" "What are the chief appliances in this plant?" "Do you do original paving with it as well as repair work?" Nearly one-half do more or less original paving.

City	Chief Appliances of Plant.	Does City Do Original Paving?
Birmingham, Ala.	Concrete mixers, portable tanks, heaters	No
Whittier, Cal.	Mixers, asphalt kettles, trucks, etc.	No
Santa Rosa, Cal.	Heater, 3-roll drier, mixer—capacity 40 cu. yd. per day	Yes
Denver, Col.	Up-to-date standard asphalt plant	Yes
Pueblo, Col.	Electrically operated heating drum and pug mixer	No
New London, Conn.	Heating plant and mixer	Yes
Tallahassee, Fla.	Asphalt kettle and small concrete mixer	No
Americus, Ga.	Concrete mixer and tar tank	Yes
Boise, Ida.	Rotary drier, asphalt tank, screen, twin pug mixer	Yes
Oak Park, Ill.	Anderson road repair outfit, 1922 model	No
Fort Wayne, Ind.	Complete plant, 1,000 sq. yd. per day capacity	No
Gary, Ind.	Concrete mixer, roller, kettles, etc.	A little
Eagle Grove, Ia.	Portable asphalt heater and tank and street tools	No
Waterloo, Ia.	Asphalt heater	No
Wichita, Kan.	Hot mixer, asphalt kettle, truck	No
Paducah, Ky.	Tar melting pots and truck and tools	Yes
Lewiston, Me.	Tar kettles, roller and scarifier	No
Attleboro, Mass.	Crusher, heating and mixing plant	No
Hudson, Mass.	Mixer, roller, tar kettle, small tools	Yes
North Adams, Mass.	Concrete mixer, brick paving tools	No
Pittsfield, Mass.	Heating pans and asphalt kettles	No
Waltham, Mass.	Concrete mixer and asphalt tank	No
Worcester, Mass.	Asphalt plant	Yes
Grand Rapids, Mich.	Portable asphalt plant	No
Hastings, Mich.	Concrete mixer and asphalt heater	Yes
Holland, Mich.	Roller, asphalt kettle, mixer with blower attached	No
Muskegon, Mich.	Roller and kettle	No
Owosso, Mich.	Mixer, boxes, small tools for brick	All brick paving
Saginaw, Mich.	1,600-yd. plant fully equipped	Yes
Sault Sts. Marie, Mich.	Two asphalt heaters, 2 bituminous mixers, rollers, hand tools	Yes
Cape Girardeau, Mo.	Portable tar kettle, roller, trucks, small tools	No
St. Joseph Mo.	Asphalt plant being built by Hetherington & Berner	No
St. Louis, Mo.	Complete asphalt plant, rollers, hot wagons	Yes
Lincoln, Neb.	Asphalt mixer and rollers	Yes
Norfolk, Neb.	Small mixer, "cooker" and hand tools	No
Laconia, N. H.	Crusher, tar pots, roller	Yes
Nashua, N. H.	Complete asphalt plant	Yes
Bridgeton, N. J.	Sheet asphalt and macadam plant	Not much
Camden, N. J.	1,000-yd. plant complete, oil tanks, storage bins	Yes
Newark, N. J.	Complete plant. See description	Bids on all asphalt work.
So. Orange, N. J.	Small mixer, steam roller, scarifier, tools	...
Summit, N. J.	Mixer for bituminous material, motor truck, steam roller	No
Trenton, N. J.	Cummer asphalt plant, 750-yd.	No, expect to
Corning, N. Y.	Concrete mixer and asphalt kettles	No
Cortland, N. Y.	Cummer asphalt plant, 800-sq. yd. capacity	Yes
New York-Manhattan	3,000-yd. asphalt plant and street equipment, kettles, etc., for stone pavement repairs	No
Niagara Falls, N. Y.	Portable asphalt plant	No
Schenectady, N. Y.	800-yd. plant, 5-ton roller	No
Watertown, N. Y.	Mixer and asphalt pan heater	No
Waverly, N. Y.	Concrete mixer, asphalt heater, tractors, etc.	Yes
Cincinnati, O.	All appliances necessary for asphalt work	No
Columbus, O.	Asphalt plant, all equipment for repairing all types of pavement	No
Dayton, O.	Asphalt plant	Small asphalt jobs
Muskogee, Okla.	Asphalt mixer, drier, kettles, tandem roller, 3-wheel macadam roller, 4 trucks	Only for city property
Eugene, Ore.	Tanks, heater, kettle, hot roller, tandem roller, concrete mixer	No
Harrisburg, Pa.	Sand heater, asphalt storage tank, mixer	No
Perkasie, Pa.	Stone crusher, asphalt heater, steam roller	Yes
Reading, Pa.	750-yd. asphalt plant	No
Scranton, Pa.	1,500-yd. Cummer plant	Furnishes asphalt material to contractors
Providence, R. I.	Four stone crushers, 2 screening plants, 8 steam road rollers, asphalt kettle and oil spreaders	Yes
Greenville, S. C.	Asphalt heater and 2 rollers	No
Jackson, Tenn.	Asphalt tank, heater, distributor	Yes
Bonham, Tex.	Portable asphalt heater	No
Salt Lake, Utah	750-yd. Hetherington & Berner asphalt plant complete	No
Barre, Vt.	Asphalt kettle and cement mixer	Yes

SHEET ASPHALT AND ASPHALT CONCRETE

City	Sheet Asphalt Area sq. yd.	Sheet Asphalt Cost	Asphalt Concrete Area sq. yd.	Asphalt Concrete Cost
California:				
Santa Ana	46,404	$115,269.00[1]	17,718	$31,814.00[1]
Connecticut:				
Hartford	2,521	10,261.00[1]	....	.....
New Haven	12,877	32,800.00[d]	5,763	13,600.00[d]
Indiana:				
Anderson	....	.....	6,000	18,000.00[k]
LaPorte	51,900	{ 1.70[b] { 3.20	....	.....
Iowa:				
Boone	140,000	2.46[c]	....	.....
Davenport	11,915	38,702.00[e]	10,494	40,556.00[e]
Kansas:				
Kansas City	....	.....	25,800	72,934.00[t]
Leavenworth	....	.....	30,000	1.14[h]
Topeka	....	.....	42,594	2.45[e]
Massachusetts:				
Haverhill	....	.....	10,346	14,237.00[a]
Lexington	....	.....	500	1.25
Michigan:				
Bay City	....	.....	17,979	63,907.00
Flint	57,000	3.56[d]	....	.....
Lansing	80,000	.....	....	.....
New Jersey:			{ 38,832	{ 3.34[e]
Jersey City	....	.....	{ 83,832[e]	{ 2.60[h]
Long Branch	87,000	3.00	....	.....
Passaic	950	30,000.00	6,511	104,567.00[k]
West New York	....	.....	15,800	1.54[h]
New York:				
Syracuse	30,600 yd.	138,080.00	24,700	124,332.00
Ohio:				
Lorain	....	.....	11,800	41,000.00[k]
Oklahoma:				
Enid	....	.....	20,633	3.37[e]
Oregon:				
Corwallis	....	.....	19,700	.....
Pennsylvania:				
Pottsville	43,000	3.50[n]	....	.....
Washington:				
Walla Walla	....	.....	38,000	1.65
Wisconsin:				
Green Bay	39,056	119,110.00	....	.....
Oshkosh	....	.....	25,160	75,480.00[t]

[a]Includes picking up surface of old macadam, grading and furnishing some new stone for base. [b]Wearing surface, excavation, curb. [c]Laid on old stone block. [d]Entire improvement. [e]Surface, base, grading, curb and gutter. [f]6 in. base, $1.39; 2 in. top, $1.07; curb and gutter, $0.75; extra, $0.65. [h]Top only. [k]Surface, base, grading and curb. [l]Wearing surface, base and grading. [n]Surface and base. [t]Part was pavement complete, part was resurfacing. [t]Surface, grading, drains and catch basins.

STONE BLOCK AND BRICK

City	Stone Block Area	Stone Block Cost	Brick Area	Brick Cost
Connecticut:				
New Haven	....	.....	2,764	$6,000.00[t]
Indiana:				
W. Lafayette	....	.....	9,000	2.52[r]
Iowa:				
Davenport		.....	3,635	15,747.00[h]
			12,148[a]	47,700[r]
Kansas:				
Kansas City			14,586.4	158,203.00[t]
Topeka		.....	3,979	3,35[b]
Massachusetts:				
Somerville	12,966	$78,013.00[c]	....	.....
New Jersey:				
East Orange	3,974	7.12[c]	....	.....
West New York	250	1.85[n]	....	.....
West Orange	800 lin.ft.	2.49[a]	....	.....

STONE BLOCK AND BRICK

New York:				
Elmira	....	.....	12,849	4.33[c]
Syracuse	101	.....	4,700	.....
Ohio:				
Jackson	....	.....	31,180[m]	100,000.00[e]
Lorain	....	.....	17,600	73,600.00[k]
Pennsylvania:				
Huntingdon	....	.....	245	3.80[c]
New Castle	....	.....	0.377 mi.	29,489.00[d]
Texas:				
Tyler	....	.....	10,000	3.25[c]
Washington:				
Seattle	....	.....	59,431	4.75
Wisconsin:				
Oshkosh	....	.....	436	2,071.00[e]
Sheboygan	....	.....	300	4.00[e]

[a]Surface only. [b]Surface and base. [c]Surface, base and grading. [d]Surface, base, grading and curb. [h]Surface, base, grading, curb and gutter. [i]Entire improvement. [l]Surface, grading, drains and catch-basins. [m]On 8-in. slag base. [r]Repaving on old base.

OTHER KINDS

City	Kind of Pavement	Area, Sq. Yd.	Cost
Illinois:			
Chicago	Creosoted wood blk	1,505	.....
	Sandstone	13,665	.....
Rockford	Creosoted wood blk	1,854	$9,628.00
Indiana:			
Fort Wayne	Plain conc alleys	21,309	43,862.00
Massachusetts:			
Haverhill	Miscellaneous	1,241	.....
Lowell	Amesite	1,301	.....
Michigan:			
Grand Rapids	Tar surface	13.5 mi.	.....
Minnesota:			
Minneapolis	Creosoted wood blk	65,418	328,330.00
Stillwater	Tar surface	153.00	7,130.00
Montana:			
Kalispell	Cinder	2,000	400.00
New Hampshire:			
Berlin	Miscellaneous	1,343.7	1.60
New Jersey:			
East Orange	Creosoted wood blk	163	6.80[c]
	Asphalt block	7,262	2.35 & 3.40
Edgewater	Asphalt block	1,200	7,000.00
New Brunswick	Asphalt block	10,443	46,084.00
New York:			
Amsterdam	Asphalt block	700	1,800.00
Glens Falls	Asphalt block	7,564	3.98
Jamestown	Asphalt block	3,126	15,762.00
Port Chester	Asphalt block	25,000	.....
Rochester	2½" asphalt block	6,050	4.21[h]
	2" creo wood block	3,850	3.56[h]
North Carolina:			
Charlotte	Oiled macadam	59,826	.....
Durham	Durax	3,461	6.33
Ohio:			
Dayton	Creosoted wood blk	7,472	43,273.00
Oklahoma:			
Tulsa	Vibrolithic	46,620	6.00
Pennsylvania:			
Hazeltown	Amiesite	20,826	74,275.00
	Asphalt block	2,357	11,527.00
Vermont:			
Rutland	Miscellaneous	440	1.62
Washington:			
Seattle	Sandstone	500	.....

[a]Surface only. [b]Surface and base. [c]Wearing surface, base and grading.

WATERBOUND MACADAM AND GRAVEL PAVEMENTS AND CEMENT SIDEWALKS

City	Waterbound Macadam		Gravel		Cement Sidewalks	
	Area sq. yd.	Cost	Area sq. yd.	Cost	Area sq. ft.	Cost
Alabama						
Birmingham	15,498.28	$30,961.00	.....	.....	43,704.17	$60,928.00
Arkansas						
Searcy	.....	.....	20,000	$20,000.00 g	.....	.....
California						
Monterey	.....	.....	20,000 ft.	.14	.....	.....
Oakland	.077 mi.	6,680.00	.....	.....	335,811	52,129.00
Santa Ana	.....	.....	.....	.....	200,000	.....
Santa Barbara	.....	.....	.....	.....	119,466	23,893.00
Santa Rosa	.....	.....	.....	.....	50,000	.18
Whittier	.....	.....	.....	.....	47,799	.20
Colorado						
Fort Collins	.....	.....	.....	.....	3,000	.16
Pueblo	.....	.....	.....	.....	15,000	.18
Connecticut						
Ansonia	.....	.....	.....	.....	9,000	.222
New London	12,000	.....	8,000	.....	119,683	.....
Williamantic	.....	.....	.....	.....	30,574	.....
Delaware						
Wilmington	3,411	.....	.....	.....	.....	.....
District of Columbia						
Washington	.....	.....	.....	.....	405,000	.22¼
Georgia						
La Grange	.....	.....	.....	.....	6 mi.	.15
Macon	.....	.....	.....	.....	1.3 mi.	.....
Idaho						
Lewiston	.....	.....	.....	.....	45,000	.15½
Illinois						
Canton	.....	.....	.....	.....	5,000	.....
Chicago Heights	.....	.....	.....	.....	11,600	2,900.00
Clinton	.....	.....	.....	.....	4,000	1,000.00
DeKalb	.....	.....	.....	.....	2,700	600.00
Galva	.....	.....	.....	.....	9,000	1,440.00
Granite City	.....	.....	.....	.....	80,000	.20
Marion	.....	.....	.....	.....	324,168	.25
Moline	.....	.....	.....	.....	264,000	.15
Riverside	.....	.....	.....	.....	99,000	24,115.00
Rockford	.....	.....	.....	.....	230,472	.....
Waukegan	.....	.....	.....	.....	34,720	9,095.00
Indiana						
Anderson	.....	.....	3,240	4,775.00	28,310	4,765.00
Decatur	.....	.....	.....	.....	7,670	.18
Elwood	.....	.....	.....	.....	15,300	3,250.00
Fort Wayne	.....	.....	.....	.....	405,810	40,885.00
Frankfort	.....	.....	8 mi.	.....	.....	.....
Gary	.....	.....	.....	.....	7,477	.....
Huntington	.....	.....	.....	.....	9,000	1,800.00
Jasonville	.....	.....	.....	.....	16,000	.28
LaPorte	.....	.....	.....	.....	1,000	.....
Marion	.....	.....	.....	.....	70,000	9,100.00
Martinsville	.....	.....	4½ mi.	3,600.00	.....	.....
Richmond	.....	.....	.....	.....	7,186	.22
Terre Haute	.....	.....	.....	.....	73,400	12,300.00
West Lafayette	.....	.....	.....	.....	7,500	.18
Winchester	.....	.....	1,800	.....	4,800	.30
Iowa						
Boone	.....	.....	.....	.....	50,000	.15½
Cedar Rapids	.....	.....	.....	.....	31,347	5,745.00
Charles City	.....	.....	.....	.....	16,915	.....
Creston	.....	.....	.....	.....	10,000	.....
Eagle Grove	.....	.....	26,700	1,540.00	1,500	.15
Emmetsburg	.....	.....	.....	.....	.....	.....
Fort Dodge	.....	.....	15,000	.30	11,000	.134
Glenwood	.....	.....	.....	.....	3,996	.....
Muscatine	.....	.....	3,960	3,600.00	9,000	1,125.00
Ottumwa	.....	.....	.....	.....	150,000	.15
Sioux City	.....	.....	.....	.....	85,000	27,100.00
Kansas						
Atchison	.....	.....	.....	.....	10,000	.19½
Junction City	.....	.....	.....	.....	49,500	.13¾
Kansas City	.....	.....	.....	.....	17,167	2,378.00
Parsons	.....	.....	.....	.....	6,000	.18
Salina	.....	.....	.....	.....	25,000	$3,000.00
Topeka	.....	.....	.....	.....	50,000	0.18½
Wichita	.....	.....	.....	.....	.....	30,500.00
Kentucky						
Bowling Green	55,000	$27,500.00	.....	.....	135,000	15,000.00
Corbin	.....	.....	.....	.....	40,500	.25
Paducah	.....	.....	.....	.....	1,800 lin. ft.	.....
Maine						
Augusta	.....	.....	.....	.....	2,133	.30
Bangor	.....	.....	5 mi.	$10,000.00	5,400	.25½
Portland	.....	.....	.....	.....	16,407	.....
Rockland	.....	.....	.....	.....	738	262.00
Massachusetts						
Athol	.....	.....	2 mi.	.....	1 mi.	.....
Brockton	.....	.....	25,460	1.10	9,690	.....
Fitchburg	.....	.....	.....	.....	18,900	.25½
Greenfield	.....	.....	.....	.....	26,100	.23
Haverhill	.....	.....	.....	.....	1,229	416.00
Hudson	.....	.....	1½ mi.	12,000.00	½ mi.	.222
Lowell	28,003	.....	.....	.....	4,185	.....
Peabody	2,000	.41	.....	.....	.....	.....
Pittsfield	.....	.....	.....	.....	43,578	.31½
Somerville	.....	.....	.....	.....	40,347	13,931.00
Webster	.....	.....	.....	.....	4,506	2.60
Worcester	.....	.....	.....	.....	23,006	.41⅔

WATERBOUND MACADAM AND GRAVEL PAVEMENTS

	Waterbound Macadam		Gravel		Cement Sidewalks	
	Area sq. yd	Cost	Area sq. yd	Cost	Area sq. ft.	Cost
Michigan						
Ann Arbor	.....	.....	.....	.....	.....	.18
Bay City	.....	.....	.....	.....	10,067 l. ft.	7,928.00
Dowagiac	.....	.....	.....	.....	18,360	.119
Grand Rapids	.....	.....	9,380	6,780.00	30 mi.	.....
Hastings	.....	.....	.....	.....	13,300	1,330.00
Holland	.....	.....	.....	.....	18,000	.13
Flint	.....	.....	16,700	1.20	330,400	.20
Iron Mountain	.....	.....	24,000	5,760.00	.....	.....
Mt. Clemens	.....	.....	2,500	1.80	10,000	.25
Pontiac	.....	.....	16,000	.....	108,000	.118
Port Huron	.....	.....	18,194	8,127.00	.....	.....
Saginaw	.....	.....	28,088	1.02	.....	.....
Sault Ste. Marie	.....	.....	30,000	.....	26,000	.....
Three Rivers	.....	.....	.....	.....	1,300	.11
Minnesota						
Duluth	.....	.....	.....	.....	200,000	.....
Ely	.....	.....	700	750.00	3,600	720.00[c]
Faribault	.....	.....	30,000	.....	.....	.....
Fairmont	.....	.....	.....	.....	10,800	1,712.00
Minneaoplis	.....	.....	.....	.....	1,697,400	219,862.00
New Ulm	.....	.....	10,000	.35	27,000	.121
Rochester	.....	.....	8 mi.	.....	4¼ mi.	.....
So. St. Paul	.....	.....	.....	.....	3,000 l. ft.	2,340.00
Stillwater	.....	.....	1,083	1,726.00	3,849	462.00
Winona	.....	.....	.....	.....	5,454	.13
Missouri						
Cape Girardeau	.....	.....	.....	.....	7,350	1,640.00
Fulton	2,000	.....	3,000	.....	.....	.....
Hannibal	.....	.....	20,000	25,000.00	19,800	20,000.00
Jefferson City	.....	.....	.....	.....	3,000	.18
Joplin	3,348	3,470.00	.....	.....	.....	.....
Kansas City	.....	.....	.....	.....	10.02 mi.	49,654.00
Marshall	.....	.....	.....	.....	15,000	.18
Monett	.....	.....	22,000	8,800.00	10,686	1,687.00
Poplar Bluff	.....	.....	.....	.....	1,000	.18
Sedalia	.....	.....	.....	.....	1 mi.	3,168.00
Springfield	.....	.....	.....	.....	½ mi.	.18
Montana						
Anaconda	.....	.....	.....	.....	7,000	.....
Billings	.....	.....	.....	.....	72,232	0.18½
Bozeman	.....	.....	8,300	8,664.00	12,960	3,240.00
Great Falls	.....	.....	16,625	9,635.00[a]	.....	.....
Kalispell	.....	.....	6,000	3,000.00[b]	1,000	220.00
Lewistown	.....	.....	.....	.....	15,000	3,300.00
Nebraska						
Chadron	.....	.....	.....	.....	30,000	.17
Columbia	.....	.....	5 mi.	.....	.....	.....
Grand Island	.....	.....	.....	.....	16,000	.13½
Lincoln	.....	.....	.....	.....	17,984	1,575.00
Omaha	.....	.....	.....	.....	21.3 mi.	90,000.00
New Hampshire						
Berlin	4,000	$1.50	.....	.....	20,963	.30
Nashua	.....	.....	.....	.....	6,387	.....
New Jersey						
Clifton	.....	.....	.....	.....	20,000	.31
Edgewater	.....	.....	.....	.....	27,400	8,800.00
Freehold	.....	.....	8,000	1.00	28,000	.20
Millville	.....	.....	12,370	.....	.....	.....
Newton	7,800	3,000.00	16,800	4,372.00	.....	.....
Passaic	.....	.....	.....	.....	3,722	936.00
Phillipsburg	5,450	.....	.....	.....	.....	.....
Plainfield	20,800	26,200.00	.....	.....	13,942	3,000.00
Rahway	.....	.....	.....	.....	13,000	4,600.00
Roselle Park	.....	.....	.....	.....	8,295	2,070.00
Rutherford	.....	.....	.....	.....	0.5 mi.	2,500.00
So. Orange	.....	.....	.....	.....	30,880	4,845.00
Summit	.....	.....	.....	.....	500	.24½
Wallington	.....	.....	.....	.....	5,364	4,661.00
West New York	.....	.....	.....	.....	19,000	.12
New York						
Amsterdam	.....	.....	.....	.....	2,000	6,000.00
Buffalo	.....	.....	.....	.....	219,818	.....
Corning	.....	.....	35,120	28,240.00	14,634	2,547.00
Elmira	.....	.....	.....	.....	113,526	.18
Endicott	.....	.....	.....	.....	15,000	.18
Fulton	.....	.....	.....	.....	10,000	.17
Gloversville	.....	.....	.....	.....	4,725	1,134.00
Lackawanna	.....	.....	.....	.....	3,600 l. ft.	1,040.00
Lancaster	0.9 mi.	.....	.....	.....	12,000	2,200.00
Niagara Falls	.....	.....	.....	.....	43,521	8,223.00
No. Tonawanda	.....	.....	.....	.....	3,000 l. ft.	5,000.00
Ogdensburg	.....	.....	.....	.....	18,225	.21
Olean	.....	.....	.....	.....	3,000	.18
Oneonta	.....	.....	.....	.....	18,792	.133
Port Chester	.....	.....	.....	.....	3,600	.....
Poughkeepsie	.....	.....	.....	.....	40,715	.25
Rochester	.....	.....	.....	.....	550,260	.18
Schenectady	.....	.....	.....	.....	47,736	8,443.00
Watertown	6,150	.90	.....	.....	25,000	.25
Waverly	.....	.....	1 mi.	.....	.....	.....
North Carolina						
Durham	.....	.....	.....	.....	90,000	20,000.00
Greensboro	.....	.....	.....	.....	180,000	.18
Oxford	.....	.....	.....	.....	33,300	.18
North Dakota						
Grand Forks	.....	.....	.....	.....	2,900	.18
Mandan	.....	.....	35,000	.....	.....	.....
Minot	.....	.....	2,000 cu. yds.	1.60	76,492	13,280.00
Wahpeton	.....	.....	.....	.....	500	.....

WATERBOUND MACADAM AND GRAVEL PAVEMENTS

	Waterbound Macadam		Gravel		Cement Sidewalks	
	Area sq. yd.	Cost	Area sq. yd.	Cost	Area sq. ft.	Cost
Ohio						
Akron					24.18 mi.	.19
Ashtabula					16,000	.20
Chillicothe					4,600	.16⅔
Conneaut					23,040	
E. Youngstown					52,000	7,280.00
Jackson					4,500	900.00
Marion					13,170	2,610.00
Middletown					9,500	1,520.00
Newark					15,290	2,220.00
Ravenna			10,000	.40	40,000	.22
Tiffin	25,000					
Troy			800 cu. yd.	.75	10,000	.13
Urbana					20,000	3,600.00
Warren					23,414 l. ft.	.18-.22
Washington			2,280	.70	4,500	.18
Oklahoma						
Chickasha					26,400 l. ft.	
Muskogee					18,000	
Norman					2 mi.	.18
Tulsa					323,464	.18
Oregon						
Ashland					6,000	1,200.00
Astoria	1,397	1,043.00			61,814	12,981.00
Dallas					90,000	.21
Eugene	6,000	.60	3,000	.45	1 mi.	.16
Marshfield					3,650	.18
Oregon City	6,000	.70			7,000 l. ft.	1.00
Portland	1,307	17,529.00			204,561	36,821.00
Salem					157,680	13,654.00
Pennsylvania						
Berwick					48,000	.15
Blairsville					1,500	.24
College Hill					1,093	.33⅓
Ellwood City					31,000	.18
Freeland			985	1,400.00	18,000	5,500.00
Hanover	14,000 ft.				6,000	
Jersey Shore	18,000	1.93			5,445	.17
Munhall					12,400	3,000.00
New Brighton					2,750	.27
Norristown	1,330	1.00				
Oil City					2,898	.25
Royersford	10,000					
Sharon					2,237 l. ft.	2,690.00
Shippensburg	22,222	.63			8,000	.15
Somerset					4,500	.30
Williamsport					2.0 mi.	
Woodlawn					37,000	.22
Rhode Island						
Cranston	5,320	1.25½				
Pawtucket					41,436	
South Carolina						
Chester			12,200	3,050.00	3,087	648.00
Greenville			8,000	8,000.00	177,795	26,669.00
South Dakota						
Mitchell			1½ mi.	3,700.00	5,000 l. ft.	4,000.00
Yankton					1 mi.	.18
Tennessee						
Clarksville	11,000	.15[a]				
Cleveland					88,650	13,900.00
Dyersburg					10,000	1,250.00
Jackson			30,000	1.00	50,000	.15
Murfreesboro	10,000					
Texas						
Bromwood			100,000	1.10[a]	10,000 l. ft.	1.25
Cameron						
Cleburne			27,050	1.25[1]	2,000	.20
Denton					54,000	.09
Eastland			10,000 cu. yd.	.35	12,000	.25
Weatherford					90,000	.08½
Utah						
Brigham City			12,469	2,130.00	20,576	3,086.00
Logan			55,000			
Provo					126,000	20,000.00
Vermont						
Bennington			3-4 mi.		5,500 l. ft.	
Rutland	10,000	.60	20,000	.50	15,300	.20
Washington						
Aberdeen			6,475	10,027.00	75,825	12,638.00
Mt. Vernon			1,872	.23	76,572	.16
Olympia					10,984	14,154.00
Pujallup			2,945 l. ft.	2,013.00	5,790	2,193.00
Seattle			35 mi.		67,445	
Walla Walla					15,000	
Yakima					97,613	19,977.00
West Virginia						
Bluefield					25,000	6,250.00
Charleston					300,000	
Clarksburg					97,200	24,000.00
Morgantown	4,564	15,000.00				
Wisconsin						
Beloit					13,500	
Eau Claire			10,000	.90		
Green Bay					10,200	2,572.00
Kaukauna					12,000	
Lake Geneva			2,000	2,100.00	7,000	1,260.00
Manitowoc					2,000 l. ft.	.75
Merrill			52,000		46,000	.09
Marinette					1,666	.14

WATERBOUND MACADAM AND GRAVEL PAVEMENTS

	Waterbound Macadam		Gravel		Cement Sidewalks	
	Area sq. yd.	Cost	Area sq. yd.	Cost	Area sq. yd.	Cost
Wisconsin (Continued):						
New London	.....	.....	.....	.....	4,000	.....
Oshkosh	.....	.....	.....	.....	3 mi.	14,260.00
Ripon	9,000	3,150.00[m]	3,000	460.00[m]	800	96.00
Sheboygan	.....	.....	.....	.....	55,829	9,789.00
Tomahawk	.....	.....	1,935	1.75	.....	.....
Wausau	.....	.....	.....	.....	158,400	.15
Wisconsin Rapids	.....	.....	.....	.....	27,000	.11
Wyoming						
Casper	.....	.....	.....	.....	124,468	.20
Sheridan	.....	.....	.....	.....	26,142	.25

[a] Surface only. [c] Surface and grading. [g] Surface, curb and gutter. [k] 2,000 yds. with grading and curb, 4,000 yds without curb. [l] Treated with asphaltic oil or tarvia. [m] Includes grading, curb, raising manholes and building catch-basins. [s] Per lineal foot, including curb and gutter.

ROAD WORK CONTEMPLATED FOR 1923

County	Kind and Amount of Work
Arkansas:	
Hempstead	$45,000—2.7 mi. conc. or asph. rd.
Colorado:	
Cheyenne	50,000—30 mi grading—7 mi. state road
La Plata	130,000—8 mi. gravel surf., incl. grad. and 30 mi. grad.; maint., $25,000
Connecticut:	
Fairfield	.....—2 mi. gravel
Florida:	
Broward	200,000—Chiefly asphalt surface
Glades	32,000—Ap. 8 mi. plain macadam
Pinellas	2,863,030—Vit. br., conc., asph. blk., sh. asph. or bit. mac.
St. Lucie	310,000—8 mi. bit. mac., 26 mi. W. B. mac., surf. treat.
Illinois:	
Bond	50,000—Complete last year's contracts and grading
Henderson	15,000—Bridges
Schuyler	500,000—15 mi. cement concrete, 120 earth maintenance
Indiana:	
Tippecanoe	500,000—14 mi. gravel—6 mi. Em. asphalt
Vermillion	.....—7½ mi. concrete
Iowa:	
Dubuque	250,000—18.2 mi. grad., incl. 40,000 cu. yd. solid rock
Kansas:	
Anderson	300,000—Grade all earth roads; 13 mi. gravel roads
Seward	40,000—Clay surf, 3⅓ mi.; Blade, 11 mi.; 4 mi. Fresno
Louisiana	
Vernon	.....—Ap. 40 mi. gravel
Michigan:	
Genesee	565,403—39 mi. grav., 1½ mi. paving
Minnesota:	
Red Lake	159,000—25 mi. grad., bridges and culv., 3½ mi. gravel
Winona	100,000—15 mi. grading, 15 mi. gravel, 30 mi. blading
Montana:	
Gallatin, Park, Madison, Broadwater, Jefferson	Ap. 300,000—Grad., drain and gravel surfacing
Nebraska:	
Cheyenne	80,000—12 mi. Federal
Grant	18,000—Grading, dirt surfacing
Lancaster	900,000—Earth work and bridge construction
Morrill	140,000—8 mi. gravel and clay surfacing
Sioux	20,000—Grading and maintenance
New Jersey:	
Burlington	175,000—Ap. 15 mi. sheet asphalt
Mercer	500,000—100,000 sq. yd. bit. mac., 50,000 sq. yd reinf. conc., 2,500 sq. yd. sh. asph., 2,000 sq. yd. brick, 4,500 sq. yd. granite
New Mexico:	
Dona Ana	.....—18 mi. gravel surfacing
New York:	
Broome	150,000—15 mi. top on 1922 base, Tarvia-bound; will lay more base
Essex	2,000—Grade and gravel
Genessee	14,500—¼ mi. mac., 1½ mi. co. rd.; final course of 4" oil penetration
Lewis	320,457—19.3 mi. bit. mac., 0.5 mi. conc.
Livingston	.....—1 mi. crown and gravel; ap. 5 mi. gravel resurface
Montgomery	8,000—¼ mi. mac., 1 mi. resurface; remainder earth road
Onelda	117,088—2 mi. bit. macadam
Orleans	Ap. 150,000—Bit. macadam
Warren	206,811—5 mi. bit. macadam
Washington	140,000—Gravel and macadam
Yates	324,000—Bit. macadam
North Dakota:	
Adams	12,000—Grading
Divide	Ap. 30,000—12 mi. state rd.; gravel 12; 18 mi. of earth rd.
Foster	.....—11 mi. grading.
Oklahoma:	
Caddo	142,429—Grading, gravel, clay
South Carolina:	
Orangeburg	130,000—Sand-clay rd., conc. rd.
South Dakota:	
Clay	55,000—36 mi. grad., 22 mi. gravel
Texas:	
Carson	12,000—Ap. 75 mi. grading
Somerville	175,000—30 mi. gravel on surfaced roads
Washington	$35,000—39 mi. grading and drainage structures
Washington:	
Island	50,000—2 mi. grad. and gravel
Spokane	750,000—.....
Wisconsin:	
Trumpealeau	300,000—Grading, shale and gravel surface; culv. and bridges

ROAD IMPROVEMENT DONE IN 1922

	Bit. Macadam (M) and Bit. Concrete (C) Amount		Cement Concrete (R = Reinforced) Amount		Plain Macadam Amount	
County	Miles or Sq. Yds.	Total Cost	Miles or Sq. Yds.	Total Cost	Miles or Sq. Yds.	Total Cost
Florida:						
Glades	.....	.....	.....	.....	25	$94,850.00
Broward	60,000 M	$0.54	.....	.....	70,000	0.42
Pinellas	.....	.....	.....	.....	10	50,000.00
St. Lucie	.....	.....	.....	.....	24	138,000.00
Illinois:						
Bond	.....	.....	5 R	$90,000.00	.....	.....
Schuyler	.....	.....	3,000 ft. R	15,000.00	.....	.....
Montana:						
Gallatin, Park, Madison, Broadwater, Meagher, Jefferson	1.0 C 5.5 M	33,000.00 22,000.00	.....	.....	.....	.....

ROAD IMPROVEMENT DONE IN 1922

County	Bit. Macadam (M) and Bit Concrete (C) Amount Miles or Sq. Yds.	Total Cost	Cement Concrete (R = Reinforced) Amount Miles or Sq. Yds.	Total Cost	Plain Macadam Amount Miles or Sq. Yds.	Total Cost
New Jersey:						
Cumberland	.....	.....	1.10 R	43,000.00	.....	.....
Mercer	28,934 M	1.80	92,835 R	3.31	.....	.....
New Mexico						
Dona Ana	.....	.....	10.4	205,800.00	.....	.....
New York:						
Broome	5 M	.....	.....	.....	.....	.....
Genesee	.....	.....	.....	.....	1½	16,300.00
Lewis	18.5 M	7,950.00	.....	.....	2½	1,789.00
Orleans	3.75 M	58,000.00	.....	.....	.....	.....
Warren	4.31 M	75,591.00	.....	.....	.....	.....
Washington	1 M	16,000.00	.....	.....	5	9,000.00
Yates	4.62 M	188,000.00	7.07 R	346,000.00	.....	.....
Oklahoma:						
Atoka	.....	.....	18 cu. yd. R	1,020.00	6	26,200.00
Caddo	.....	.....	.....	58,714.00	.....	.....
South Carolina:						
Orangeburg	.....	.....	3	55,000.00	.....	.....
Texas:						
Washington	.....	.....	32 R	864,000.00	.....	.....
Washington:						
Spokane	.....	.....	14.12	435,000.00	97.27	621,930 00

ROAD IMPROVEMENT DONE IN 1922

County	Grading Amount Mi. or Sq.Yds.	Cost	Earth Surfacing Amount Mi. or Sq.Yd.	Cost	Gravel Amount Mi. or Sq. Yd.	Cost	Culverts & Bridges Included in Cost
Arkansas:							
Hempstead	20,000	$0.30	12	$4,000.00	19	$152,000.00	40 br. & culv.
Colorado:							
Cheyenne	148	.....	253	.....	29	.....	4 br., 40 culv.
La Plata	50	50,000.00	....	.....	12.5	80,000.00	$23,000 for br. & culv.
Florida:							
Broward	90,000 cu. yd.	0.81	....	.....	....	.....	No
Glades	29	33,650.00	....	.....	....	.....	No
Pinellas	40	24,000.00	....	.....	....	.....	No
St. Lucie	24	12,000.00	....	.....	....	.....	No
Illinois:							
Bond	60	10,000.00	....	.....	....	.....	.....
Schuyler	125	85,000.00	....	.....	....	.....	60 culv. & br.
Indiana:							
Tippecanoe	....	.....	....	.....	16	.....	.....
Vermillion	....	.....	....	.....	3	5,000.00	.....
Iowa:							
Dubuque	60,000	29,000.00	....	.....	2	6,000.00	No
Kansas:							
Anderson	30	10,000.00	100	6,000.00	8½	107,000.00	Yes
Seward	3	150.00	1½	0.50s	....	.....	No
Louisiana							
Vernon	170,000 cu. yd	37,000.00	....	.....	20	60,000.00	No
Michigan:							
Genesee	....	.....	....	.....	48	408,000.00	Yes
Minnesota:							
Red Lake	30	60,000.00	11½	11,000.00	18½	36,500.00	12 br., 29 culv.
Winona	20	25,000.00	14	2,800.00	5	4,500.00	No
Montana:							
Custer	70	14,000.00	....	.....	9	7,200.00	280 culv., $16,800
Gallatin, Park, Madison, Broadwater, Jefferson	90	360,000.00	....	.....	60	180,000.00	Yes
Treasure	....	488.00	....	.....	....	.....	New br., $678
Nebraska:							
Cheyenne	200	20,000.00	....	.....	....	.....	No
Gosper	12	5,000.00	75	5,000.00	....	.....	No
Grant	10	200.00	15	300.00	....	.....	No
Hamilton	60	5,000.00	....	.....	....	.....	No
Lancaster	500	100,000.00	....	.....	....	.....	.....
Morrill	3	.....	3	10,000.00	11	22,000.00	No
Sioux	32	6,400.00	....	.....	....	.....	No
New Jersey:							
Cumberland	..	.....	....	.....	6½	49,000.00	Yes
New Mexico:							
Dona Ana	41,600 cu. yd.	12,500.00	10	2,300.00	20	40,000.00	All small culverts
New York:							
Essex	47	.....	....	.....	9	.....	No
Washington	25	.....	....	.....	15½	6,000.00	Yes
North Dakota:							
Adams	118	9,000.00	....	.....	....	.....	70 culverts
Divide	20	54,180.00	....	.....	....	.....	$5,784
Foster	....	.....	....	.....	10	26,000.00	No
Oklahoma:							
Atoka	6	6,500.00	....	.....	....	.....	Yes
Caddo	....	24,478.00	....	.....	....	.....	104, cost, $84,985
Coal	13	10,300.00	...	.....	....	.....	
South Carolina:							
Orangeburg	....	28c-32c	....	.....	....	.....	All culv. 36" or less
South Dakota:							
Clay	47.5	26,702.00	....	.....	13.03	42,179.00	.....
Texas:							
Carson	75	50.00	....	.....	....	.....	.....
Somerville	...	.....	4	300.00m	4	9,400.00m	Yes
Washington	32	98,000.00	32	7,000.00	....	.....	No
Washington:				25,000.00			
Island	...	.....	....	.....	5	4,000.00	No
Wisconsin:				.....			
Trempealeau	30	125,000.00	15		15	70,000.00	No

m—per mile. s—per yard.

REINFORCEMENT AND RESURFACING

County	Reforcement Used in Concrete Roads	Materials Used in Resurfacing—Concrete Pavements	Brick Pavements	Macadam and Gravel
Arizona:				
Maricopa	.....	.....	.....	Asph. concr. 1½" to 2"
Pinal	.....	.....	.....	Caliche and disintegrated granite
Arkansas:				
Hempstead	35 lb. per 100 sq. ft.	.....	.....	.....
Colorado:				
Mesa	.....	Tarvia	.....	.....
Delaware:				
New Castle	.....	.....	.....	Bit. concr. or macadam
Florida:				
Broward	.....	.....	.....	Asph. oil and sand
Illinois:				
Bond	⅜ round bars	.....	.....	.....
Fulton	State standards	Asphalt	Asphalt	.....
Green	State standards	.....	.....	.....
Kane	State specifications	.....	.....	.....
Mason	State specifications	.....	.....	.....
Peoria	Bars along edge	Tarvia	.....	.....
Sangamon	½" bars on edge	.....	.....	.....
Schuyler	Illinois specifications	.....	.....	.....
Stephenson	⅜" bar along each edge	.....	.....	.....
Whiteside	¾" bars	.....	.....	.....
Will	Mild steel bars	.....	.....	.....
Williamson	⅜" bars on both edges	.....	.....	Gravel, asphalt, cold patch.
Winnebago	.....	.....	.....	Refined tar for macadam
Indiana:				
Tippecanoe	.....	.....	Tarvia	Gravel
Vigo	.....	Emulsified asphalt	Emulsified asphalt	.....
Iowa:				
Buchanan	½" square bars	.....	.....	.....
Des Moines	½" square bars	.....	.....	.....
Dickinson	.....	.....	.....	Concrete
Greene	.....	Tarvia	.....	.....
Kossuth	½" square bars	.....	.....	.....
Woodbury	½" square bars	.....	.....	.....
Kansas:				
Allen	.....	.....	.....	Concrete and bitumen.
Barber	.....	.....	.....	Clay and gravel
Bourbon	.....	.....	.....	Bitumin. surface treat.
Reno	½" and ¾" bars	Asphalt	Asphalt	.....
Seward	.....	.....	.....	Clay
Kentucky:				
Rockcastle	.....	.....	.....	Cold patch and new rock or gravel
Whitley	40 lbs.	Ky. rock asphalt	Ky. rock asphalt	.....
Louisiana:				
Caddo	.....	.....	.....	Heavy asphaltic oil
Lincoln	.....	.....	.....	Sand-clay gravel
Michigan:				
Branch	5' bars, 6¼' centers, with center joint	.....	Sheet asphalt in city	Cold tar and asphalt
Charlevoix	.....	.....	.....	¼" chips and tarvia
Chippewa	.....	.....	.....	Cold patch tar and pea gravel
Delta	.....	.....	.....	Surface treatment
Emmet	.....	.....	.....	Tarvia A & crushed rock
Genesee	80 lb.	.....	.....	.....
Kalamazoo	.....	.....	.....	Tar and asphalt
Kent	¾" bars, circumferential	.....	.....	.....
Luce	.....	.....	.....	Asphalt and refined tars
Muskegon	⅜" side bars, ⅝" cross bars	.....	.....	Asphaltic macadam
Ottawa	Center plate, ¾" rods	.....	.....	.....
St. Joseph	.....	.....	.....	Gravel and tarvia
Minnesota:				
Mille Lacs	.....	.....	.....	Clay and gravel
Nebraska:				
Lancaster	.....	.....	Sheet asphalt	.....
New Mexico:				
Dona Ana	.....	Asphaltum	.....	Gravel
New York:				
Broome	.....	.....	.....	Tarvia
Lewis	.....	.....	.....	Bit. macadam
Oneida	.....	.....	.....	Tarvia
Warren	N. Y. State standards	Bit. macadam	.....	Bit. macadam
Yates	5 lbs.	.....	.....	Concrete top in some cases
Ohio:				
Allen	71 lb. mesh	Ky. rock or blt. concr.	Relay brick	Oil or asph. surface treat
Ashtabula	Kind not determined	.....	.....	Tar or asph. surface treat.
Ashland	½" bars	.....	New brick or asphalt	.....
Carroll	.....	.....	.....	Bit. material M. T.
Clark	.....	A1 and T1	.....	A1 and T1
Fairfield	Rods	.....	.....	.....
Hancock	Illinois standard	.....	.....	Tar and asphalt
Harrison	.....	Tar patch	.....	Blast furnace slag
Henry	Mesh 56 lb.	.....	.....	Stone and tar
Holmes	.....	.....	Tar	.....
Lucas	40 lb. and 56 lb.	.....	.....	Stone and tar
Medina	¼" sq. deformed, 6" centers	New concrete	Concrete	.....
Paulding	½"	.....	.....	.....
Putnam	.....	.....	.....	M T tar & No. 6 stone
Richland	⅜" rods, 5½ lb. per sq. yd.	.....	Rock asphalt	Tar and asphalt
Ross	.....	Asphaltic materials	Brick	Cut-back
Trumbull	Rods	Asphaltic concrete	.....	Tar & asph. surface treat.
Van Wert	⅝" round rods	.....	.....	.....

REINFORCEMENT AND RESURFACING

County	Reforcement Used in Concrete Roads	Materials Used in Resurfacing — Concrete Pavements	Brick Pavements	Macadam and Gravel
Oklahoma:				
Beaver	½" sq. and ¾" round bars	Tarvia A and B	.....	Tarvia A and gravel
Creek	Bates section	Asphalt	.....	.....
McIntosh	.....	.....	.....	Camden asphaltic oil
Tillman	Kind not decided	.....	.....	.....
Tennessee:				
Johnson	.....	.....	.....	Tarvia
Texas:				
Cameron	Bars, 4 lb. per sq. yd.	.....	.....	.....
El Paso	Asphalt	.....	.....	Asphalt or gravel
Fannin	Illinois state standards	.....	.....	Invert. penetra., topping, 1"
Harris	.....	Asphalt	.....	Shell
Hidalgo	¼" bars every 18" each way	.....	.....	Rock asphalt
Kaufman	½" sq. bars	.....	.....	Bitumen
Palo Pinto	.....	.....	.....	Asphalt
Rockwall	One ⅝" round each side	.....	.....	.....
Smith	¾" bars	.....	.....	.....
Washington	.....	Refined tar		.....
Virginia:				
Albermarle	.....	.....	.....	Bit. penetration mac.
Augusta	.....	.....	.....	Tar and asphalt
Pittsylvania	.....	.....	.....	Tarvia & ¾" lime. chips
Tazewell	.....	.....	.....	Bitumen & crushed limest.
Washington:				
Clarke	.....	Asphaltic concrete	.....	Clay and rock
Pierce	.....	Asphaltic concrete	.....	.....
Skagit	½" bar	Concrete	.....	.....
Whatcom	.....	Asphalt	.....	.....
Whitman	Steel bars	.....	.....	.....
West Virginia:				
Mineral	.....	.....	Reconstruct subgrade and replace brick	Limestone & cold tar
Upshur	.....	.....	Asphalt	.....
Wood	Mesh 65 lbs.	Tarvia K. P. or equal	Asphalt	.....
Wisconsin:				
Fond du Lac	½" rods, 4' centers trans.	.....	.....	.....
Forest	85 lbs.	.....	.....	.....
Jefferson	½" bars	.....	.....	.....
Juneau	Mesh	Oil and chips	.....	.....
Lacrosse	.....	Tar	.....	Tar
Richland	½" sq. bars	.....	.....	.....
Sheboygan	½" bars every 4 ft.	.....	.....	.....
Trempealeau	½"	.....	.....	.....
Vernon	Mesh	.....	.....	Tarvia and gravel
Walworth	½" sq. & ⅝" sq. bars	.....	.....	.....
Waushara	.....	.....	.....	Clay and gravel

TOTAL COUNTY, STATE AND FEDERAL FUNDS

County and State	Spent in 1922	Available for 1923
Arkansas:		
Hempstead	$172,000	$45,000
Colorado:		
Cheyenne	81,193	50,000
La Plata	152,000	185,000
Florida:		
Broward	350,000	200,000
Pinellas	50,000	.....
St. Lucie	150,000	310,000
Glades	140,500	32,000
Illinois:		
Bond	100,000	50,000
Henderson	25,000[a]	15,000
Schuyler	100,000	500,000
Indiana:		
Tippecanoe	ap. 320,000	500,000
Iowa:		
Dubuque	200,000	250,000
Kansas:		
Anderson	266,000	300,000
Seward	12,000	40,000
Louisiana:		
Vernon	133,000	.....
Michigan:		
Genesee	ap. 800,000	565,403
Minnesota:		
Red Lake	147,833[g]	159,000
Winona	100,000	100,000
Montana:		
Custer	62,000[a]	200,000
Gallatin, Park, Madison, Meagher, Broadwater and Jefferson	ap. 1,000,000	ap. 300,000
Sheridan	48,092	14,000
Treasure	1,935[c]	11,000
Nebraska:		
Cheyenne	50,000	80,000
Gosper	55,000	.....
Grant	.....	18,000
Hamilton	60,000	.....
Lancaster	350,000	900,000
Morrill	32,000	140,000
Nance	65,000[a]	45,000
Sioux	21,000	20,000
New Jersey:		
Burlington	315,000	175,000
Mercer	.....	500,000
New Mexico:		
Don Ana	260,000	.....
New York:		
Broome	160,000	150,000
Essex	18,000[f]	2,000
Genesee	16,000	14,500
Lewis	250,918	320,457
Montgomery	.....	8,000
Oneida	ap. 116,000	117,088
Orleans	ap. 71,000[a]	ap. 150,000[a]
Warren	200,000	206,811
Washington	ap. 120,000[a]	140,000[a]
Yates	534,000	324,000
North Dakota:		
Adams	ap. 13,000	12,000
Divide	60,000	ap. 30,000
Foster	26,000	.....
Oklahoma:		
Atoka	58,000	26,500
Caddo	168,127	142,429
Coal	47,000	36,030
South Carolina:		
Orangeburg	ap. 300,000	130,000
South Dakota:		
Clay	70,343	55,000
Texas:		
Carson	15,000	12,000
Somerville	50,000	175,000
Washington	1,212,000	835,000
Washington:		
Island	52,000	50,000
Spokane	1,056,930[f]	750,000
Wisconsin:		
Trempealeau	275,000	300,000

[a]—county funds only. [c]—on bridges. [f]—county and state aid. [g]—does not include money spent by state on trunk roads

ROAD IMPROVEMENT DONE IN 1922

County	Kind	Amount	Cost
Arizona:			
Pinal	Bridges and culverts	.....	$9,225
Yuma	Structures	50	20,000
	Maintenance	500 mi.	45,000
Arkansas:			
Pike	Bridge	1	30,000
Connecticut (Towns):			
Windsor	Plain macadam	1 mi.	6,500
Delaware:			
New Castle	Concrete and bit. concrete	10.8 mi.	317,000
	Maintenance and repair	.....	102,285
	Bridges	.....	74,000
	Bridge maintenance	.....	40,000
Florida:			
Broward	Plain macadam	70,000 sq yds.	42 cts.
Glades	Plain macadam	25 mi.	94,850
Pinellas	Plain macadam	10 mi.	50,000
St. Lucie	Bit. surface treatment	5 mi.	25,000
	Plain macadam	24 mi.	138,000
Illinois:			
Macoupin	Bridges	.....	18,700
	State aid road work	.....	17,850
Peoria	Oiling	120 mi.	45,000
	Maintain dirt road	174 mi.	36,000
Stark	Maintenance	10 mi.	1,000
Will	State aid repairs	200 mi.	22,447
Woodford	Oil testing earth roads	36 mi.	10,717
	Patrol	25 mi.	1,144
	Culverts	37	12,483
Indiana:			
Jennings	Plain macadam	14.33 mi.	100,357
Shelby	Plain macadam	9.25 mi.	6,030 per mi.
Tippecanoe	Em. asphalt	1 mi.	.....
Iowa:			
Adams	Bridges	90	89,626
	Maintenance	110 mi.	32,805
Appanoose	Concrete bridges and culverts	34	70,000
Benton	Bridge	1	75,000
Buchanan	Maintenance	183 mi.	50,000
	Bridges and culverts	.....	64,000
Clay	Bridges and culverts	.....	50,000
Hamilton	Bridges	6	40,000
	Culverts	40	100,000
Lucas	Bridge, culv. and maintenance	.....	40,000
Mitchell	Concrete bridges	74	85,000
	Tile drainage	13 mi.	25,000
	Maintenance	83 mi.	41,000
Poweshiek	Reinf. cover. bridges	.....	60,000
Wapello	Bridges and culverts	63	44,000
Worth	Bridges and culverts	.....	25,000
Kansas:			
Allen	Bit. surface on macadam	4½ mi.	13,350
Cowley	Plain macadam	3 mi	6,700 per mi.
Crawford	Chat road	16 mi.	6,000 per mi.
Ellis	Maintenance	.....	8,926
	Dragging	.....	5,564
Jackson	Bridges	43	42,350
	Maintenance	.....	15,000
Kingman	Maintenance	.....	25,000
	Concrete bridges	.....	15,000
Lincoln	Grading and maintenance	.....	35,000
Lyon	Culverts and repairs	.....	50,000
Seward	Earth	2 mi.	.....
Kentucky:			
Boyle	Plain macadam	2 mi.	12,000
Fleming	Plain macadam, 12 ft.	0.4 mi.	1,600
	Maintenance	.....	37,500
Gallatin	Maintenance	152 mi.	11,368
Jefferson	Plain macadam	6 mi.	60,000
	Concrete bridge	1	38,250

ROAD IMPROVEMENT DONE IN 1922— (Continued)

County	Kind	Amount	Cost
Ohio—Continued			
Lucas	Plain macadam	108,783 sq. yd.	164,262
	Willite	22,818 sq. yd.	114,090
Madison	Gravel, repair	80 mi.	83,364
	Plain macadam, repair	5 mi.	10,000
Marion	Plain macadam	8 mi.	54,894
	Maintenance	.....	150,000
Paulding	Plain macadam	15 mi.	117,000
Putnam	Plain macadam	12 mi.	96,000
	Kentucky rock asphalt	11 mi.	231,000
Richland	Plain macadam	5 mi.	60,000
	Maintenance of macadam	.....	55,000
Ross	Bridges	.....	75,000
Sandusky	Plain macadam	2 mi.	12,000
Van Wert	Plain macadam	4 mi.	12,000
Oklahoma:			
Atoka	Plain macadam	6 mi.	26,200
McIntosh	Culverts on 12 mi. of road	.....	4,100
Texas	Concrete bridges	.....	13,000
Tillman	Concrete structures	665 cu. yd.	15,012
South Carolina:			
Greenwood	Top soil surfacing	8.9 mi.	25,543
Orangeburg	Sand-clay	150 mi.	3,200 per mi.
South Dakota:			
Deuel	Reinforced concrete culvert	132 cu. yd.	2,141
Tennessee:			
Clay	Bridge	1	4,000
Texas:			
Harris	Plain macadam	1 mi.	48,000
	Maintenance	.....	264,000
Kames	Rock asphalt, 1"	150,000 sq. yd.	90,000
Shelby	Culverts, 18" to 36" C.M. pipe	1,600 ft.	4,000
	Timber bridges	15 — 360 ft.	4,300
Smith	Gravel treated with asphalt	5 mi.	1,250
Somerville	Maintenance and bridges	.....	11,400
Wise	Sand-clay	252 cu. yd.	1,400
	Culverts	500 cu. yd.	11,785
Virginia:			
Augusta	Plain macadam	5 mi.	27,500
	Loose macadam	1¾ mi.	7,700
	Cement culverts	5	2,000
Pittsylvania	Maintenance, soil roads	100 mi.	30,000
Tazewell	Plain macadam	9 mi.	45,000
	Maintenance	20 mi.	17,000
	Repair work	.....	30,000
Washington:			
Grays Harbor	Bridges	10	38,000
Jefferson	Maintenance	.....	46,000
West Virginia:			
Berkeley	Plain macadam	25 mi	25,000
	Asphalt (by state)	5 mi.	100,000
Boone	Maintenance	.....	20,000
Mineral	Plain macadam	2 mi.	20,000
	Shale	12 mi.	40,000
	Maintenance	.....	20,000
Wood	Maintenance, earth roads	800 mi	71,180
Wisconsin:			
Florence	1 bridge and 14 culverts	.....	8,200
	Engineering and inspection	.....	3,296
	Patrol	.....	9,000
	Machinery	.....	10,000
Fond du Lac	Culverts and bridges	15 mi.	11,026
Jackson	Shale	11¼	18,122
Juneau	Bridges	5	10,600
	Maintenance	86.9 mi.	22,600
Richland	Plain macadam	1 mi.	4,832
	Shale	4 mi.	9,063
Sauk	Plain macadam	3 mi.	20,000
Vernon	Guard rail	.....	10,000
	Maintenance	.....	113,600
Walworth	Maintenance, county roads	283 mi	68,593

HIGHWAY WORK CONTEMPLATED FOR 1923

Continued from the April Issue, Page 146.

County.	Kind and Amount of Work.
Texas—Continued	
Palo Pinto	50 mi. bit. topped macadam
Red River	Gravel surface state highways, concrete drainage structures—$250,000
Rockwall	12 mi. single track concrete.
Runnels	10 mi. earth grading with conc. structures
Schleicher	9.86 mi. bit. macadam, including concrete drainage structures.
Shelby	60 mi. sand-clay, 20 mi. gravel.
Smith	30 mi. gravel, 7 mi. bit. surface macadam, 4 mi. concrete.
Somerville	10 mi. gravel surfacing.
Tom Green	15 mi. bit. surface on waterbound mac.
Uvalde	25 mi. bit. top, 60 mi. gravel, grading, drainage structures.
Washington	9 mi. grading, drainage structures.
Wise	1 mi. gravel and macadam—$150,000.
Virginia:	
Albemarle	70 mi. grading & draining, 20 mi. macadam, 2 mi. concrete.
Augusta	4 mi. bit. macadam, 1 mi. gravel, 5 mi. waterbound macadam.
Pittsylvania	mi. conc., $300,000; 15 mi. soil, $60,000.
Tazewell	Grading, macadam, bridges (county only).
Washington:	
Clarke	7 mi. grading, 3 mi. paving, 255-ft. conc. arch (state).
Ferry	15 mi. grading and gravel surfacing.
Grays Harbor	10 mi. gravel road, 1 mi. conc. pavement, reconstruct trestle bridges.
Island	2 mi. grading and graveling.
Jefferson	1½ mi. grading and gravel, $40,000.
Lewis	3 steel bridges.
Lincoln	7 mi. concrete, 20 mi. gravel.
Okanogan	15 mi. grading (gravel).
Pend Oreille	10 mi. primary, $110,000; 1 mi. permanent heavy, $15,000.
Whatcom	2.5 mi. conc. permanent 16 ft. wide.
Whitman	15 mi. grading, including culverts, 5 mi. crushed rock surfacing.

County.	Kind and Amount of Work.
W. Virginia:	
Berkeley	5.25 mi. waterbound macadam.
Boone	Grading and drainage, $164,000.
Mineral	11 mi. plain macadam, 15 mi. grading.
Taylor	7.67 mi. plain concrete, 9.0 mi. bit. macadam, 40,000 sq. yd. brick.
Upshur	10 mi. grading, 3½ mi. paving.
Wood	Cement concrete, gravel & improved earth.
Wisconsin:	
Adams	8 mi. gravel surfacing, 10 mi. clay-gravel surfacing.
Ashland	Grading, surfacing, bridges.
Bayfield	Reconstruct old roads, repair few bridges.
Florence	15 mi. grading, 8 mi. surfacing with mine rock and gravel.
Fond du Lac	9 mi. surfacing, 40 mi. gravel & grading, 6.6 mi. conc. surface, 34 mi. paving.
Forest	Grading, $50,000; bridges, $25,000.
Jackson	Grading and surfacing.
Jefferson	46 ml. concrete.
Juneau	20 mi. grade and gravel.
La Crosse	Bit. macadam.
Polk	Grading and gravelling.
Portage	30 mi. gravel, 6 mi. 18-ft. concrete.
Richland	12 mi. grading, 12 mi. gravel surfacing, ½ mi. concrete, 3 mi. shale.
Sauk	Macadam, grading, bridges & culverts.
Sawyer	Construction, $61,000; gravel, $30,000; bridges, $5,000.
Shawano	Grading, culverts, surfacing with gravel.
Sheboygan	42 mi. gravel, 5 mi. concrete.
Trempealeau	Grading, shale surfacing and gravel, culverts and bridges.
Vernon	Shale surfacing, $14,000; 66,000 sq. yd. concrete, $12,000; grading, bridges.
Walworth	18 mi. gravel, 28 mi. concrete.

Owen	Maintenance	.....	.....	15,000
Rockcastle	Bridges	.....	.....	60,000
	Maintenance	.....	.....	20,000
Woodford	Plain macadam	10 mi.	.....	35,000
Louisiana:				
Beauregard	Bridges	.....	.....	5,000
Caddo	Plain macadam	3 mi.	.....	36,000
	Uvalde rock asphalt, 2"	5.3 mi.	.....	180,000
	Uvalde rock asphalt, cold, 1"	¾	.....	40,000
	Oil surfacing	100 mi.	.....	.....
Michigan:				
Cass	Plain macadam	7 mi.	.....	110,000
Chippewa	Plain macadam, 16 ft.	7 mi.	.....	91,000
Delta	Plain macadam	5 mi.	.....	40,000
Kalamazoo	Plain macadam	14 mi.	.....	140,000
Luce	Surface treatment	7 mi.	.....	9,000
	Maintenance	60 mi.	.....	26,000
Muskegon	Plain macadam	12 mi.	.....	120,000
Ottawa	Sheet asphalt on crushed stone	1¼ mi.	.....	48,000
St. Joseph	Plain macadam	7 mi.	.....	20,000
Minnesota:				
Big Stone	Culverts, 12" to 72"	1,783 ft.	.....	2,830
	Maintenance	.....	.....	12,200
Chisago	Reshaping	45 mi.	.....	7,000
	Maintenance	160 mi.	.....	71,000
Mahnomen	Maintenance	.....	.....	7,952
Norman	Bridges and culverts	.....	.....	24,000
Pine	Concrete bridges	6	.....	11,363
Red Lake	Bridges and culverts	.....	.....	26,811
Stevens	Portable culverts	2,249 ft.	.....	4,293
	Reinforced concrete culverts	104.72 cu. yd.	.....	2,814
Swift	Bridge, 2 x 20' slab	.....	.....	2,393
Wadena	Bridge, 45 ft. truss	.....	.....	4,300
Washington	Maintenance	165 ml	.....	30,000
Montana:				
Cascade	Sub-grade and drainage	50 mi.	.....	18,000
Custer	Culverts	280	.....	16,800
Gallatin	Bridges	.....	.....	83,135
Granite	Culverts	.....	.....	3,000
Golden Valley	Maintenance	.....	.....	15,672
Madison	Bridges	.....	.....	9,711
Sheridan	Maintenance, roads	.....	.....	3,296
	Maintenance, bridges	.....	.....	3,675
	Bridges	.....	.....	12,241
Treasure	Bridges	.....	.....	678
Nevada:				
Esmeralda	Repairs	.....	.....	2,000
New Jersey:				
Burlington	Sheet asphalt	8 mi.	.....	240,000
	Maintenance	225 mi.	.....	75,000
Mercer	{ Sheet Asphalt	21,058 sq.yd.	.....	3.21
	{ Granite Block	5,850 sq.yd.	.....	5.96
New York:				
Dewitt	Filling washouts	.....	.....	5,000
	Plain macadam	¾ mi.	.....	3,000
Genesee	Plain macadam	1½ mi.	.....	16,300
North Dakota:				
Cass	Maintenance	Earth roads	.....	25,000
	Bridges	.....	.....	60,000
Grant	Bridges	.....	.....	30,500
Ohio:				
Allen	Plain macadam	2 mi.	.....	.....
Ashland	Resurfacing, plain macadam	5 mi.	.....	20,000
Clark	Bridges	.....	.....	3,242
	Culverts	15	.....	3,032
Fairfield	Maint., gravel and limestone	213 mi.	.....	120,000
Hancock	Plain macadam	150,000 sq. yd.	.....	160,000
	Stone, repairs	.....	.....	100,000
Harrison	Resurfacing, plain macadam	3 mi.	.....	12,000
Henry	Plain macadam	7 mi.	.....	75,000

Minneapolis Street Maintenance

Resurfacing oiled streets by scarifying, pulverizing, blading and rolling. Method of operation described in detail.

Street maintenance in Minneapolis is conducted under a somewhat unusual system, in that there is a street commissioner for each of the thirteen wards. These commissioners are under civil service and so are well protected. Each is independent of the other twelve and in most respects is entirely independent of the city engineering department, although nominally the city engineering department is designated by the city council as the general street commissioner. The director of the Bureau of Municipal Research, F. L. Olson, who has furnished us with most of the information contained in this article, states that so far as he can learn there is no consultation by either the commissioner or the two aldermen of any of the wards with the city engineering department concerning the equipment and methods to be used in street work and the result is that the city is likely to have as many different kinds of equipment as it has wards.

One of the wards, the Second, is operating a new piece of equipment, and Mr. Olson recently inspected the work being done by it. He describes the method of resurfacing a street with the use of this machine, a combined tractor and roller with a scarifier and grader attached, as follows:

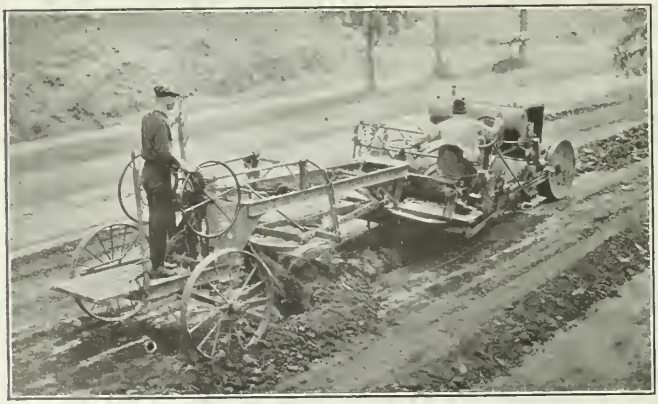
The machine was operated from the rear by one man who controlled the scarifier and was able to watch the results of his work because of the location of the driver's seat. There was no grader attached to the machine, but a grader can be hooked on in a minute or two. This gives the driver opportunity to watch the work of both machines. The tractor weighs, as now built, between 8 and 9 tons. It moves along at a good rate of speed and is very successful in scarifying, grading, pulverizing and rolling the soil, despite the oil which tends to break up the dirt in cakes.

In explanation of this last statement, Mr. Olson states that a somewhat similar machine of another make working on another street broke out the pavement in large-sized cakes which were bound together by the oil used by the city for keeping down the dust on its dirt streets; the blade in this case not smoothing out the surface satisfactorily, with the result that traffic produced numerous chuck holes soon after treatment.

In this Second Ward work the plan of operation was to scarify the street first, then have a man blade it for purposes of breaking up the larger cakes of dirt. Next the tractor with a grader attached or separately drawn, as the case may be, again bladed the broken-up surface in order to further pulverize the dirt. The dirt was continually brought toward the center of the street in windrows and this turning-over process, plus the blading and the action of the heavy drum, served to reduce the dirt to very small particles. After the blading, the final action was for the tractor, with the scarifier lifted and without the grader, to roll the street. The last process was the oiling, which varied in amount with the character of the soil and the traffic.

As developed by the latest practice in Minneapolis, the scarifier travels up one side of the street the full length of the work (not more than one-half mile for an eight-hour day) and back the other, scarifying to a depth equal to or slightly greater than the penetration of the oil. The grader is not used on the first cut, but on the second the grader man throws to the right the material loosened by the first and second cuts. This procedure is followed forward and back until the entire road surface has been completely scarified, the material then being laid up in a number of windrows.

The material in the windrows from oiled roads is very lumpy, sometimes in pieces two or three feet square. The machine is then driven on top of these rows with the scarifier raised, the grader throwing the material to the sides, making new windrows. This is continued until the material is thoroughly pulverized, when it is graded back into place to give a uniform, level foundation; after which the road is thoroughly lap-rolled and is then in condition to be re-oiled and sanded.



RESURFACING A MINNEAPOLIS STREET.

"The particular street in question," says Mr. Olson, "was three blocks long, approximately 1,100 feet. The work began at 10 o'clock, an hour was taken off for noon, and all operations up to the point of oiling were completed by 4:30. I did not remain to see the oiling but assume that it would have taken not to exceed an hour of additional time. In this particular case there was one man driving the tractor at a daily wage of $5 and a second man operating the grader. The street

commissioner estimates an expense of $3 per 8-hour day for gasoline, 50c for oil, but has not allowed anything for repairs. The reason for this omission is the lack of necessity for making repairs so far, beyond replacing a few of the teeth in the scarifier. An estimate of five years' life for the machine with a $3-a-day rate of depreciation is charged also. According to the commissioner, it is possible to complete from six to eight blocks per day. Judging from the operation on this one street, I would be inclined to say that six blocks was very near the maximum.

"No accurate accounts are kept, no time or service reports are turned in by the men who operate the machines, therefore most of the figures given are estimates. . . . I urged upon Mr. Ludwig the desirability of keeping accurate reports and accounts of the work done in order that an accurate record of the unit cost might be arrived at. Personally, my impression from this day's observation is that the machine is well worth the investment and that it is doing satisfactory work." The machine used in this work was that known as the "Gray Giant" combination road and street maintainer.

Lincoln County Road Work by Day Labor

Lincoln County, Washington, does a large part of its road work, including the crushing of gravel, by its own forces and equipment.

During 1922 it operated a plant at Davenport, another near Almira with two crushers, one near Sprague consisting of two crushers, which it rented from Adams County, one near Creston, one near Wilbur and a double crusher near Reardan.

The accompanying table shows the itemized cost during the season of operating each of these plants and utilizing the material so obtained in road improvement, and the average cost per cubic yard in place of the material so turned out and utilized.

The work at the Davenport plant included stripping the pit, crushing, screening, hauling, subgrading and spreading.

The Almira force crushed the entire product to 1-inch and resurfaced five miles of highway; and also, as a separate account, resurfaced the connection through the town of Almira, the cost of $870 being paid by the town. In addition to the items given in the table, this force also spent $3,383 in grading and ditching, which was paid by the state.

At Sprague the entire product was crushed to 1-inch and used on 4.3 miles of state maintenance westward from the town, together with 132 cubic yards placed on a county road. In addition, this gang spent $4,049 in widening shoulders, deepening ditches, etc.

At Odessa, no crusher was used, but a gravel loader and a grizzly was used for handling the gravel, which was used in resurfacing with an average haul of 4 miles.

At Creston there was an extreme haul of 6 miles on one road and work done on three other roads, while 1,445 yards of base rock was wasted.

The Wilbur plant was a poor pit containing an excess of sand and 2,096 cubic yards of sand were wasted. Graveling three miles of new grading, using 6,501 cubic yards of gravel, cost $6,176.

At Reardan three miles of new grade was surfaced, using 4,726 cubic yards and the remaining 304 yards was sold for $312, leaving the net cost of these three miles $4,845. The average haul was 3½ miles. The work was done in sixteen days and nights.

In his report on this work, which was sent to us by J. L. Thayer, construction engineer, he gives also prices by contract work, which can be compared with the force account work above referred to. One highway, 4.2 miles long, near Reardan, completed in 1922, cost for grading and graveling with two-course crushed gravel, 2-inch and 1-inch, $23,165 or $5,516 per mile. The price paid for gravel in place was $1.46.

Near Wilbur 6.52 miles of grading and surfacing with crushed rock, 1-inch and 2-inch, was done at a cost of $35,468 or about $5,460 per mile, the price of crushed rock in place being $1.70. Another contract for three miles of standard 24-foot road, 7% maximum grade, was graded by contract for $4,710. This was graveled by day labor for $6,176, 2,166 cubic yards per mile of crushed gravel being used. Near Reardan another highway three miles long was graded by contract for $5,964, being 24 feet wide with 7% maximum grade. This also was graveled by day labor at a cost of $4,845, using 1,575 cubic yards per mile.

ROCK CRUSHING AND IMPROVED ROAD WORK IN LINCOLN CO., WASHINGTON, IN 1922, BY DAY LABOR

Location of plant	Davenport	Almira	Sprague	Odessa	Creston	Wilbur	Reardan	All plants
Repairs and supplies	$598.18	$1,919.81	$319.09	$239.15	$999.63	$902.89	$393.62	$5,402.32
Labor	2,857.35	2,963.97	1,418.75	605.05	2,921.33	4,696.10	2,644.60	18,107.15
Gas and oil	1,915.74	1,805.57	1,788.34	547.45	1,291.66	2,549.68	1,472.60	11,371.04
Cook house supplies	331.39	238.29	.....	.....	.....	.....	237.41	1,142.82
Tires	506.12	336.34	498.80	.....	432.65	352.90	258.66	2,385.47
Rental of equipment	.....	300.00	893.72	.....	.....	.....	.....	1,193.72
Miscellaneous	56.37	274.37	10.47	.....	168.79	193.01	150.13	1,723.14
Work for town	.....	870.00	.....	.....	.....	.....	.....	.....
Total cash paid	$6,265.15	$8,708.35	$5,294.85	$1,391.65	$5,814.06	$8,694.58	$5,157.02	$41,325.66
Work done:								
2-inch base, cu. yds.	3,650	.....	.....	.....	2,069	2,376	.....	8,095
1-inch fine, cu. yds.	6,849	8,340	6,448	1,461	2,849	6,752	5,030	37,729
Average cost per cu. yd. in place	$0.60	$1.05	$0.82	$0.95	$1.18	$0.95	$1.02	$0.90

Sewer Cleaning in Belle Plaine, Iowa

The main outfall sewer at Belle Plaine, Iowa, which, extends several miles from the city proper, at one time became stopped up. After trying different methods of removing the stoppage, a turbine machine was employed. As there were no water mains nearby, water for operating the sewer-cleaning machine was obtained by pumping sewage from the sewer by means of an old fire engine. Among the materials removed by this cleaning was a cement bag filled with sand that had been carried down into the sewer during a previous attempt to clean it.

Recent Legal Decisions

CONTRACT TO KEEP IN REPAIR PAVEMENT INSIDE "TRACKS" CONSTRUED

In an action by a city against a street railway company to recover money paid by the city for repairs to a street for a distance of two feet outside of the rails of the company under an ordinance accepted by the company providing that the company should pave the part of any street through which its railway may be laid that lies inside of the rails and two feet outside thereof, and to keep the parts of the streets *inside of their tracks* at all times *in good repair* the city contended that the words "rails" and "tracks" are not synonymous; that "rails" is limited to the metal which forms part of the "tracks," white "tracks" includes, not only the rails, but the ties, ballast, etc. The Court of Errors and Appeals of New Jersey holds, City of Bayonne v. Public Service Ry. Corporation, 119 Atl. 9, that this may be true when crossing railways, levying taxes, etc., are involved; but in the case at bar the words "inside" and "outside" clearly show that the *tracks* mentioned mean *rails*.

CONSTRUCTION OF STATE-AID HIGHWAY THROUGH CITY WITHOUT CITY'S CONSENT

The Georgia Supreme Court holds, Lee County v. Mayor of City of Smithville, 115 S. E. 107, that the state, through its Legislature, has as much power and control over the laying out, construction, maintenance and closing of the highways, streets, lanes and alleys of municipal corporations as it has over other public highways. It may change, alter or abolish either class of these highways at will. It may exercise this power directly or may delegate it to municipalities, the counties of the state, or to any other constituted body. It can withdraw the power, in whole or in part, at will. It is the duty of the state to lay out public highways and improve them in cities as well as in unincorporated county districts.

The Legislature has power to establish a state road, and tax the cost and expense thereof upon the county, without the approval of the county. Under Georgia Laws, 1919, p. 242 et seq., providing for a system of state-aid roads, it is held that the State Highways Department, co-operating with the county commissioners, can build a public road through an incorporated town without its consent and against its will.

COUNTY BOARD MAY ALTER COURSE OF ROAD, THOUGH NEW PART LOCATED ONLY IN ONE TOWN

The Minnesota Supreme Court holds, Nelson v. County Board of Nicollet County, 191 N. W. 913, that the county board had jurisdiction of a petition for the alteration of an existing county road by laying out between two given points therein a new road, thereby straightening and shortening the course of the old road. It was immaterial that the part of the new road thus petitioned for was only in one town. The order establishing such alteration ipso facto vacates the part thereof which lies between the termini of the new part after the lapse of two years as provided by the Minnesota statute.

STREET SPRINKLING A GOVERNMENTAL FUNCTION—CITY NOT LIABLE FOR NEGLIGENCE OF ITS DRIVER

The Georgia Court of Appeals hold, McCrary v. City of Rome, 115 S. E. 283, that the sprinkling of the streets by a city is an act connected with the maintenance of the public health, and therefor is a governmental function; and the city is not liable for the negligence of one of its employees while actually operating the street sprinklers or water wagon for the purpose of sprinkling the streets. This is true, although the sprinkling is done by the waterworks department of the city, and although that department is operated by the city for gain and profit. The court will take judicial notice of the well-known fact that the dust in the streets of a city is liable to be infested with deleterious germs, and that the winds, or swiftly moving automobiles or street cars, cause the dust and germs to fly about and settle in the eyes, ears, noses and bronchial tubes of persons passing along the streets, causing illness and disease, and that this may be prevented by sprinkling.

HIGHWAY DISTRICTS AND THEIR SPECIAL COMMISSIONERS NOT LIABLE FOR NEGLIGENCE IN ROAD CONSTRUCTION

The St. Louis Court of Appeals, Missouri, holds, Sharp v. Kurth, 245 S. W. 636, that special road districts are public corporations and quasi public subdivisions of the county and the state, and, in the absence of a statute making them liable for their negligent acts, are not liable for negligence in the building and construction of public works, such as roads and bridges. And the special commissioners of such districts are not liable for their mitsakes of judgment or their acts of negligence in doing work. They can only be held liable individually when their acts are done maliciously and wilfully.

PAYMENT OF LABORERS' WAGES BY GENERAL CONTRACTORS TO SUBCONTRACTORS RELEASES FORMER

A foreman for subcontractors on highway construction not only knew when cash payment to the subcontractors was made by the general contractors, but acquiesced in the method adopted for payment. The general contractors paid the subcontractors enough to liquidate the labor claims, but the foreman was not paid in full by the latter. In an action against the general contractor, the Arkansas Supreme Court holds, Miller v. Koetzel Bros., 245 S. W. 33, that the foreman had constituted the subcontractors his agent in the collection of his wages, and payment to the subcontractors released the general contractors.

PUBLIC WORKS.
CITY COUNTY STATE
A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"
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Improving Wilmington's Water Supply

By C. W. Smedberg*

Changes in and enlargement of purification plant, relocation of intake, and installation of motor-driven pumping plant, result in furnishing a water of more reliable quality at a reduction in operating cost sufficient to pay for the improvements.

The city of Wilmington, N. C., during 1922 made extensive improvements to its water supply involving an expenditure of more than a quarter of a million dollars. They included providing a new source of supply and intake line, overhauling the filter plant and building a new filter basin and reconstructing the coagulating basin, and installing dry-feed machines and motor-driven centrifugal pumps on the high-pressure system.

The plant is a municipal one, acquired by purchase from a private company in 1909. It was enlarged in 1910 and again in 1919, there then being twelve 500,000-gallons-per-day filter units, a clear-water well of 160,000-gallons capacity, three coagulating basins and a 1-1/2-million-

*Sanitary Engineer, Carolina Engineering Company, Wilmington, North Carolina.

RECONSTRUCTING COAGULATING BASIN.
Showing uncompleted mixing chamber, entrance diffusion wall, dividing wall, overflows and outlet weir.

TOOMER'S CREEK INTAKE STATION AND SUBMERGED SUCTION PIPE.

gallon storage reservoir, together with a pumping station.

The source of the supply was the northeast branch of the Cape Fear river, on the east bank of which is located the pumping station and filtration plant. This stream carries the flow of numerous small creeks that originate in swampy lowlands and has a high color and relatively low turbidity. It is affected by the tide, which has an average variation here of 3 feet, resulting in a change of the quality of the water with each tide.

With the growth of the city and of the sewerage system, outlets were constructed emptying into the river below the intake, following which the amount of sewage backed up to the intake by the tide has increased. It was found necessary to pump all of the sewage from one section of the city to a point below the intake, which pumping involved considerable expense, and some trouble has been experienced in maintaining the pumping station in continuous operation, and very frequently raw sewage has reached the intake. Table No. 1 gives analyses of the old supply averaged for three years and indicates the heavy load placed on the plant. This condition, combined with the deterioration of the filter plant, resulted in the safety of the water supply becoming more or less questionable, while during periods of severe drought salt water has backed

Table No. 1
Analytical Data Northeast Branch Cape Fear
Averaged over period of Three Years

Year	Color	Turbidity	Alkalinity	Co	Cl	Total Hardness	Permanent Hardness	Bacteria per c.c. at 20° C.	Bacteria per c.c. at 37° C.	B Coli index per 100 c. c.
1920—133	94	8	8	21	21	13	...	999	530*	
1921—161	48	11	8	155	37	26	2972	3085	3255	
1922—160	33	10	6	15	8	1	1781	1333	2712	
Ave.—151	58	10	7	64	22	13	2376	1806	2166	

*Dilutions to 0.10 c.c. only.

Table No 2
Analytical Data Toomer's Creek Water
(Compiled from Report of G. F. Catlett)

	High Tide						
	Color	Turbid.	Alk.	Bacteria per c.c.	B. Coli 10	B. Coli 1	B. Coli 0.1
Maximum	110	65	25	400	+	0	0
Minimum	72	22	16	29	0	0	0
Average	86	38	21	166	59%	0	0
	Low Tide						
	Color	Turbid.	Alk.	Bacteria per c.c.	B. Coli 10	B. Coli 1	B. Coli 0.1
Maximum	100	45	28	450	+	0	0
Minimum	78	17	18	48	0	0	0
Average	86	29	22	214	60%	0	0

up into the intake, although this is located thirty miles from the ocean. A realization of these objectionable features was the cause of making the improvements above referred to.

The new supply is obtained at a point approximately 2-1/8 miles west of the present intake, on Toomer's creek, which is a cutoff on the Northwest Branch of the Cape Fear river, approximately 7 miles long and is practically a long, sluggish canal. The Northwest Branch and the Northeast Branch join near the north end of Wilmington, and the new intake is connected to the pumping station by an intake line across the V-shaped strip of land between these two

24-INCH INTAKE DISCHARGE LINE.
Power transmission line follows pipe line. Intake station in background.

branches. Toomer's creek was recommended as a source of supply by Professor Earl B. Phelps in 1913 and later by George F. Catlett, formerly chemist and bacteriologist of the plant. Table No. 2 gives maximum, minimum and averages of Mr. Catlett's results, which indicate that this water can be purified by chemical filtration more economically than that of the east branch and that it is only slightly polluted.

THE NEW INTAKE

The new intake is 11,389 feet distant from the original filtration plant (which is continued at the same site) and is connected with it by means of a line of 24-inch bell-and-spigot Class A castiron pipe, of which 636 feet across the Northeast Branch is of the flexible-joint type developed by the U. S. Castiron Pipe and Foundry Company, while the balance is supported on wooden bents above the surface of the ground, which is flat, swampy tidal land, boggy and wet and covered with water at high tide, but with firm, sandy soil 6 to 48 feet below the surface. The supporting bents are made of creosoted wood piles with 8-inch butts driven to a penetration that gives a maximum bearing of 10,000 pounds per pile. Each bent consists of two piles cut off at the proper level and capped with 8x8-inch creosoted wood, the bents being so located as to support each pipe one foot back of the bell. The line is level throughout.

The submarine line across the Northeast Branch was laid in accordance with the methods developed by the city of Norfolk, Virginia, on its Lake Prince development. A channel was first dredged for the full width of the crossing and of a depth sufficient to meet the requirements of the War Department for navigable streams, varying from 35 feet in the 100-foot

width of ship channel, to 2 feet at each bank, where connections were made to the bell-and-spigot pipe. The 35-foot depth gave a 5-foot cover over the pipe. The flexible-joint pipe was laid in this trench from a wooden cradle suspended between two barges and moved forward as each joint was made, the cradle being purchased from the city of Norfolk. When the cradle reached the further shore, the upper portion was cut off and removed, but the lower portion was permitted to remain as a support for the pipe, because the river bottom here is a series of rock ledges forming steps. Connections to the bell-and-spigot pipe were made with sleeves and the line was anchored to concrete deadmen by means of iron rods. A Venturi meter was placed in this pipe line so that an accurate record can be kept of the water pumped and as assistance in regulating the chemical dosage.

In order to deliver the water to the purification plant, a low-lift pumping plant was located at the new intake at Toomer's creek in a building 18x20 feet, comprising a brick superstructure on a reinforced concrete substructure supported by wooden piles which project 6 inches into the footing and floor slab. This was built in a cofferdam of Wakefield sheet piling carried several feet below low-water level. Difficulty was experienced in placing the concrete for the footing and floor slab, the hydrostatic pressure developed by the rise and fall of the tide breaking the concrete before it attained its final set. To

FLEXIBLE JOINT USED IN RIVER CROSSING.

solve this difficulty, the cofferdam was filled with fine beach sand and the substructure was built on this, above the influence of the tide, as a monolith, and was then settled into place on the piles as a caisson; the sand, thoroughly saturated with water, being removed from under it by an ordinary contractor's gasoline engine-driven double diaphragm pump. The footing and floor slab and walls of the substructure were designed to withstand a 14-foot head of water and resist flotation, and a 3 per cent. mixture of toxament was used as a waterproofing agent. The floor is of such depth that the pumps are submerged at all times.

The pumping equipment consists of two motor driven Morris centrifugal pumps with a capacity of 4,000,000 gallons per day against a 100-foot head, and a small float-operated sump pump. The raw-water pumps have a 24-inch suction and discharge. The motors are automatically controlled from the filtration plant and are G. E. 3-phase, 60-cycle, 2,200 volt, 100-horsepower, direct-connected to the pumps and mounted on the same base. The sump pump is vertical, motor-driven. Up to the present no occasion has developed for using it except to dispose of the waste water from the glands of the pumps, as the concrete walls are impermeable to water and the interior of the structure is bone dry under a 9-foot hydrostatic head.

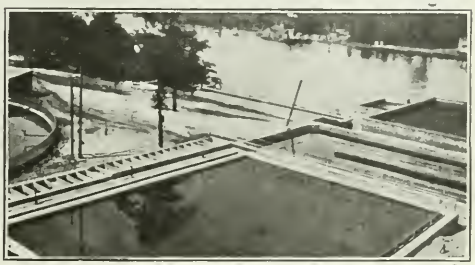
The station is completely wired for lights, with sockets for extension cords and lamps at convenient points. Current for lighting and pumping is furnished from the filtration and pumping station, the power being controlled from the switchboard at this station.

PURIFICATION PLANT

Water from the new intake on reaching the purification plant flows through a new, closely baffled mixing chamber and thence through a reconstructed coagulating basin to the filters. The plant being located on the hillside at the river-bank, the basins are set at different elevations, all higher than the filters, number one being on the hilltop, number two on the slope and number three approximately 5 feet above the filters.

Basins 1 and 2 had a longitudinal dividing wall with inlet and outlet at the same end, while in basin 3 the inlet and outlet are at opposite ends. Velocities through the different basins varied from 1.2 to 2.4 feet per minute, which was found to be too high for effective sedimentation. After studying the operation of these basins with a view to securing lower velocities it was decided to construct the mixing chamber along one side of basin number 1 and reconstruct this basin, and use number 2 and 3 for secondary treatment of the water, if necessary.

In the old plant all chemicals were added at the suction side of the raw-water pumps and no other mixing secured except in passing through the centrifugal pumps; but in the new supply a mixing chamber was thought desirable to insure a thorough mixing of the chemicals with the water. The mixing chamber is of the up-and-over type, 6 feet wide, 12 feet deep and



INLET END OF MIXING CHAMBER AND WEST HALF OF RECONSTRUCTED COAGULATING BASIN.
Basins Nos. 2 and 3, filter and storage reservoir in background.

148 feet long. Wooden baffles are spaced 14 inches center to center and the velocity is .8-foot per second when treating 6,000,000 gallons a day, and the detention period is 20 minutes. Chemicals are introduced directly over the raw water inlet. The outlet of the mixing chamber is into a covered channel separating the mixing chamber from the coagulating basin and extending the full length of the basin, gates and valves being provided which will permit directing the water into basin No. 1 or by-passing it to either or both of the other basins. The mixing chamber can be drained by means of drain lines and sumps, and flap gates in the baffles extending to the bottom of the chamber. No accumulation of silt or floc is anticipated with the velocity that is maintained in the mixing chamber.

In reconstructing basin No. 1 to serve as a coagulating basin, the dividing wall was removed and the direction of flow changed to pass across the width of the basin, which is 60 feet, instead of along the 148 feet of its length. This gives a surface velocity of 0.35-foot per minute instead of 1.7 feet per minute, without changing the detention period of approximately three hours when operating at 6,000,000 gallons per day. Water is admitted to the basin from the mixing chamber by means of six 12-inch sluice gates in the outlet channel equally spaced along the length of the basin. In order to distribute the entering water uniformly across the basin, a wooden wall was placed in front of the inlet for the full length of the basin, composed of 2x8 material with 1-inch spaces between the separate planks; while a similar wall is placed across the center of the basin to break up surface currents due to wind action. The water leaves the basin over a concrete skimming weir to four 12-inch outlet lines, which, in turn, discharge into a 16-inch cast-iron header which conveys the water to either of the other two basins or direct to the filter bed. Bell-mouth overflows connected to the sewer prevent the overflowing of the basin. In addition, there are drain pipes, by-passes, effluent lines, etc.

The old solution tanks and chemical feed apparatus were too low to supply chemicals to the new mixing chamber by gravity, and dry-feed machines were installed at a higher elevation, one for alum and two for lime, being of the type manufactured by the Roberts Filter Manufacturing Company. The machines are motor-driven and controlled by individual switches. A revolving screw conveyor works the chemical from the hopper to the front end of the machine, where it drops into a cast-iron up-and-over mixing box, where it is taken into solution by a stream of water flowing through the box continuously. The machines are provided with two speeds and with three adjustments of the conveyor speed for each speed, permitting a wide range of chemical dosage. The chemical solutions are carried to the mixing chamber and basins through 1-1/2-inch galvanized iron pipe, each turn or connection in this being made with a tee, one opening of which is plugged. High-pressure water connections are made to the solution lines, enabling the operator to flush the lines daily and prevent the deposition of chemicals in the line.

The filter plant now consists of twelve 500-gallon units. The under-drainage system of each unit formerly consisted of a 6-inch central cast-iron semi-elliptical manifold with laterals of 1-1/2-inch and 1-1/4-inch wrought-iron pipe and umbrella-type strainers. All but four of the filter units had been equipped with Earle controllers, and four with hydraulic valves and tables, and these were discarded and Simplex controllers provided throughout (the other four already having Simplex controllers) and all valves are now hand-operated from floor stands on the operating floor. As high-velocity wash was contemplated, all gravel, sand and under-drainage systems were removed, the old manifolds being too small for this type of wash. The old manifold was replaced with a semi-circular manifold of area equivalent to a 10-inch pipe, with laterals of 1-1/2-inch galvanized pipe on 6-inch centers, carrying strainers 6 inches apart, the strainers of the old system being cleaned and used again. The full pressure of the wash-water tank was then applied to the system and any strainers blown out were replaced and the test continued until all held. Gravel was then placed as follows: 5 inches of 2-1/2-inch to 1-inch gravel, 4 inches of 1-inch to 5/8-inch, 4 inches of 5/8-inch to 3/8-inch, 3 inches of 3/8-inch to 3/16-inch, and 2 inches of 3/16-inch to a number 10 mesh, followed by 30 inches of sand with an effective size of 0.43 mm. and a uniformity coefficient of 1.51. The wash water troughs were raised to give 24 inches from the sand to the top of the trough, the troughs from eight of the units being combined and used in four units to secure the capacity needed with the high velocity wash, and new troughs provided for the remaining four units.

Each unit is equipped with loss-of-head gages and sample pumps of the Humphrey type, set on cast-iron stands. A sampling cabinet is provided for drawing water from the raw-water main and the coagulating basin and composite filter water.

A 50,000-gallon steel wash-water tank on a 40-foot tower provides water for high-velocity wash, the tank being filled from the high-pressure main and kept at a constant level by means of a Golden Anderson altitude valve.

The work of overhauling the filters was so planned and conducted that shutdowns of only short duration were necessary for cutting in new valves and piping.

A 160,000-gallon filtered water well, constructed in 1906, is continued in use and water is pumped from it to the distribution system, chlorine gas being added at the pump suction. Duplicate chlorinating units are provided.

A fully equipped laboratory is maintained at the plant jointly by the County Board of Health and the Water Department, with a trained chemis and bacteriologist in charge. Complete analyses and daily records of operation are maintained.

HIGH PRESSURE PUMPING PLANT

The new high-pressure pumping plant is motor-driven, the old steam units being held in reserve. There is a standard General Electric five-panel switchboard, fully equipped; each of the service pumps, the booster pump, the Toomer's creek intake pumps and the incoming power each having a panel. The local power company furnishes 2-phase, 60-cycle, 2300-volt current at the plant, which is converted to 3-phase by Scott connected transformers.

The service pumps are motor-driven centrifugals with a capacity of 3,000,000 gallons per day against a 200-foot head. Each pump has an independent suction connected to a 30-inch header and can discharge independently into the high-pressure system or into the suction of the booster pump. These and the booster pump, complete with motors, were furnished by the Morris Machine Works.

The booster pump has a capacity of 6,000,000 gallons per day against a 300-foot head and is used only for giving pressure greater than ordinary. General Electric slip-ring motors are used, direct-connected to the pumps by flexible couplings. Drum controllers and resistors are used with the service and booster pump motors. Power from the switchboard to the Toomer's creek intake station is conveyed through a submarine cable under the river and thence over a three-wire overhead pole line, the submarine cable being a standard steel-clad lead-incased of three No. 1 conductors, insulated for a working pressure of 3,000 volts. The overhead ground wire is quarter-inch galvanized steel wire and the conductors are No. 1 B. & G. gage hard-drawn bare copper wire. The 30-foot juniper poles are bolted to creosoted stub piles by galvanized iron bolts and wrapped with wire. The intake pumps take the 2200-volt power direct from the line, but transformers step down the voltage to 220 for operating the sump pump and for lighting.

BENEFITS DERIVED

The improved plant furnishes a water supply that, although slightly polluted, can receive no pollution from the sewage of the city either now or in the future, or from sea-water. In addition, it operates more economically than the old plant. Flocculation tests made by George D. Norcom, director of the plant laboratory, showed that the new supply would require only half as much chemicals to secure results as the old supply, and this has been confirmed by service operation.

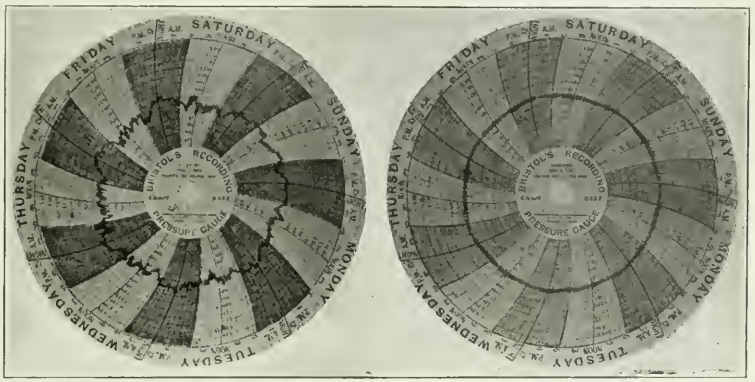
Other economies are secured by the discontinuance of sewage pumping and by the electrification of the high-pressure pumping equipment. It is estimated that the annual saving will be sufficient to offset the interest on the bond issue and also retire the serial bonds as they become due. The total cost of these improvements, including engineering, was approximately $260,000.

The engineers for this work were the Carolina Engineering Company of Wilmington, North Carolina, of which G. H. Bishop is chief engineer, and the writer sanitary engineer. Tucker & Laxton, Inc., of Charlotte, N. C., were the general contractors, E. L. Scruggs being their superintendent; The Diamond Steam Boat & Wrecking Company of Wilmington was the sub-contractor for the submarine pipe line. J. H. Cowan is mayor and commissioner of public safety; J. E. Thompson, commissioner of finance; R. C. Cantwell, commissioner of public works; McKean Maffitt, superintendent of water; George D. Norcom director of laboratory, and J. H. Sweeney, chief engineer of plant. The writer is indebted to Mr. Norcom and Mr. Sweeney for the operating and historical data incorporated in this paper.

Cleaning Water Mains in Manhattan

Results secured from cleaning water mains in Manhattan, Kansas, were described in the June issue of "Kansas Municipalities," by B. L. Ulrich, superintendent of water works. The salient points of his paper are given below.

The city obtains its water supply from the underground flow of the Blue River valley by means of a series of wells. This water contains a large amount of iron, averaging from 7 to 10 parts per million, and an average total hardness of 450 parts per million. Pumping and storage of the water resulted in aeration and a partial oxidation of the iron, with the result that a part was precipitated and settled throughout the distributing mains.



Previous to cleaning mains. After cleaning mains.

PRESSURE GAUGE RECORDS SHOWING DROP DURING PEAK LOADS.

A serious loss of pressure became noticeable about 1914, but not until 1922 could the voters be persuaded to authorize a bond issue to cover a filtration and iron removal plant and the cost of cleaning the mains. Following an educational campaign, in that year they voted a bond issue for this purpose, in which $14,000 was included for cleaning the mains. A preliminary investigation showed that about eight miles, comprising all of the original system laid in 1887 and some later extensions, required cleaning. In January, 1922, a contract was made with the National Water Main Cleaning Company to clean between five and ten miles of 4-in. to 12-in. pipe, the company to furnish superintendence and equipment and the city to furnish all labor and material required. Work was commenced in August and 7.8 miles of pipe was cleaned at a total cost of $4,807 or approximately 11.6 cents per foot. The force used, in addition to the cleaning company's superintendent, consisted of a foreman, one caulker, six men and a truck. The average amount of pipe cleaned per day was three blocks. The work was completed in three months.

The method of cleaning was that ordinarily employed by this company, consisting in opening the pipe at the two ends of a stretch to be cleaned, inserting a cleaning machine and drawing it through by cable.

During the progress of the work no consumers were deprived of water service for more than one day, as in every case the section shut off to be cleaned was completed and the water turned back on the same day. Following the cleaning, every service was tested for possible stoppage and in only a few cases was any trouble encountered in the clogging of curb cocks or service lines and such stoppages were easily removed by means of special force pumps.

Incident to the cleaning a number of interesting conditions were found that would otherwise never have been discovered. A 6-in. mass of lead was found in an 8-in. main, and at two other places pieces of 1 x 4-in. boards 12 feet long were found in mains that had been in service for 35 years.

In order to demonstrate the effectiveness of the pipe cleaning, Mr. Ulrich had, before cleaning, cut a 4-ft. section from a 10-in. main, which showed incrustation all around it 2½ inches thick. Following the cleaning of the same pipe, another section was cut out near the first one showing the cleaned pipe in almost perfect condition with all the deposit and incrustation removed without injury to the original coating on the pipe. These two specimens were exhibited in a store window in the business section and quite successfully combatted the usual criticism of uninformed citizens.

The effect of the cleaning is shown by charts taken from a recording gauge located at the City Hall, one for a week prior to the cleaning and the other for a week following the cleaning. These show a great improvement in constant and even pressure maintained at all times after the mains had been cleaned. As the city now has in successful operation a softening and iron removal plant, it is not anticipated that removal of incrustations and deposits will again be required.

Dover's Water Works Auto Truck

Last year the water department of Dover, N. H., purchased a 1½-ton Reo truck to take the place of the horse and wagon formerly used. The purchase was made on February 28, the cost was $1,623.75. During the remaining ten months the cost of upkeep was $39.94 for horn, curtains, repairs, etc., $144.68 for gasoline, $15 for oil and $10 for chauffeur, a total of $209.62, or at the rate of 68.5 cents per day. The total distance traveled was 4,725 miles, giving a cost of 4.4 cents per mile.

The superintendent of the department, Henry E. Perry, in his annual report, compares this with the cost of the horse and wagon during the same period of 1921, stating that the stable account had been $441.50; shoeing, repairs to wagon, etc., $96.65; veterinary service, $30.50; a total of $568.65, or a rate of $1.85 per day.

Size of Filter Sand*

Effect of size of sand on operation details and results, as indicated by comparison of filters at Lima, Ohio.

By E. E. Smith, 2nd†

The six units at the Lima filtration plant have separate outlets to the clearwell, so that it has been customary to collect separate samples at times of general sample collection for plant control, using the average bacterial count from separate plates as the estimate for filtered water prior to disinfection. During the year 1921, all bacterial counts were made with an incubation temperature of 37° C.; during the year 1922 a change was made to an incubation temperature of 20° C., all counts being made with "Standard Methods" agar. Exact measurement of initial and final loss of head have been made and other engineering data have been collected, the summaries of which are herewith presented. The mechanical analyses of sand samples were made at the laboratory of the State Department of Health in December, 1921.

The filters may be divided into two groups according to differences in physical characteristics of the filter sand. Filters 1, 3 and 5, located on the west side of the filter gallery have a sand of smaller size and greater uniformity than filters 2, 4 and 6, on the east side. Those filters having the finer and more uniform sand also have a slightly thinner sand layer, or at least a greater distance between the sand line and the tops of the wash-water troughs. During the two years' observations the rate of washing has been uniformly the same—24 to 25 in. rise of wash water—applied for one minute at a low rate, then the remainder of the recorded time of wash at full opening of the wash water valve.

*Paper before Ohio Conference on Water Purification.
†Superintendent of Filtration at Lima, Ohio.

Table I—Description of Filters

Filter number	1	3	5	2	4	6	1, 3, 5	2, 4, 6
Effective size (mm.)	0.37	0.37	0.38	0.44	0.42	0.42	0.37	0.43
Uniformity coefficient	1.22	1.27	1.21	1.36	1.38	1.43	1.23	1.39
Distance of top of sand to top of trough (in.)	29.62	29.88	29.75	28.38	27.00	29.00	29.75	28.15

Table II—Comparison of Performance of Filters as Measured by 37° C. Bacterial Count, Year 1921

Filter number	1	3	5	2	4	6	1, 3, 5	2, 4, 6
Filter efficiency (bacterial removal)	81%	81%	82%	77%	77%	80%	81%	78%
Average wash water used (gals.)	28,900	28,900	28,500	28,800	28,100	28,500	28,800	28,500
Time of wash (minutes)	4:40	4:34	4:51	4:12	4:15	4:11	4:42	4:13
Length of run (hours)	25:00	22:44	25:50	30:46	30:10	30:21	24:31	30:26
Initial L-of-H (ft.)	1.45	1.27	1.38	1.23	1.12	1.35	1.37	1.23
Final L-of-H (ft.)	11.00	11.10	11.00	10.90	10.90	11.10	11.03	10.97

Table III—Comparison of Performance of Filters as Measured by 20° C. Bacterial Count (January-October, 1922)

Filter number	1	3	5	2	4	6	1, 3, 5	2, 4, 6
Filter efficiency (bacterial removal)	64%	59%	72%	69%	68%	71%	65%	69%
Average wash water used (gals)	26,100	25,300	26,100	25,400	24,800	25,500	25,800	25,200
Time of wash (minutes)	4:26	4:05	4:18	3:41	3:40	3:48	4:12	3:43
Length of run (hours)	16:00	14:29	15:07	18:32	19:24	18:01	15:13	18:39
Initial L-of-H (ft.)	1.44	1.35	1.59	1.32	1.21	1.52	1.46	1.35
Final L-of-H (ft.)	8.46	8.53	8.45	8.36	8.50	8.47	8.48	8.44

The time of wash has been fixed to maintain as nearly as possible the same volume of wash water passing through the filter at each wash.

A study of the figures recorded shows that the filters with the finer sand require approximately one-half minute longer to pass the same quantity of wash water; they have consistently higher initial loss-of-head; and always shorter runs, requiring higher percentages of total wash water. The figures for bacterial removals do not indicate any such consistent differences, but show practically the same removals. For the two periods the removal of B. Coli has been practically the same—93 per cent.

All of the filters show sand of size and uniformity falling within the limits suggested by Mr. Dittoe in November, 1921—less than 0.45 mm. During 1922, the filters were allowed to reach a final loss-of-head of approximately 8.5 ft., while in 1921 they were permitted to reach the practical limits of loss-of-head—11 feet; and the total percentages of wash-water for the two periods—4.1 for 1922 and 2.8 for 1921—result from such change in operation. Other conditions have also caused the increase in percentage; namely, poor coagulation in cold weather, filter growths in warm weather, as well as the attempt to consistently produce a filter effluent below a confirmed B. Coli index of 2 per 100 cc.

Filter runs for those filters with the coarser sand were approximately 24 per cent. longer than those with the finer sand. Had all filters been equipped with filter sand of 0.43 mm. effective size, it is probable that the average percentage of washwater would have been reduced possibly half of this difference, or instead of 2.8 for 1921 it might have been 2.5 per cent., and instead of 4.1 for 1922 it might have been 3.6 per cent. Although these conclusions are based upon small differences in size of filter sand, they are also based upon many observations. They serve to indicate that small differences in size of sand are important, and that careful attention to size and grading of filter sand may have far-reaching results in operation.

Water Services in St. Paul

During 1922 St. Paul installed 2,500 new service connections, varying in size from ⅝ inch to 6-inch. A meter is placed on every connection except those for automatic fire sprinkler installations or fire pumps, "where it is evident that the water will not and cannot readily be used for any other purpose than for fire," says the annual report, probably in a spirit of charitable optimism.

During the year, a ruling was made by the Board of Water Commissioners that on and after January 1, 1923, the minimum size connection to be installed would be a ¾". It was also decided that service connections of ¾" to 1½" inclusive, would be of lead, and that service connections of 2" and over would be of cast iron. Galvanized iron, which was formerly used, did not prove satisfactory in all cases. In some portions of the city the galvanized iron deteriorated very rapidly and gave a great deal of trouble after a very few years of service.

Waterworks Services

The Committee on Standardization of Services of the American Waterworks Association at the annual Convention this year reported on the mechanical and chemical problems of waterworks services in the progress report which it submitted.

Concerning mechanical considerations, it stated that, considering not only the first and replacement costs of services but also taking into account the interruption of service and inconvenience of street openings, it is no exaggeration to say that a service that will last twenty-years is worth five times one that will last only ten years. In fact, a service should be expected and planned to last as long as the water main to which it is connected.

"Many materials are used for services and many have been of the temporary class requiring frequent renewals. Galvanized iron has been, probably, the most popular in past years and many services installed forty and fifty years ago

of old style wrought iron galvanized are in service today. Steel pipe has not had as long a test to show its lasting qualities, but it is doubtful if either can be compared favorably with cast iron as a long-lived material.

"The life of lead is well known, but the effect on health of its use is not so well understood. While there are few cases of lead poisoning from the use of lead water pipes on record, the information on the subject is meagre.

"Brass pipe has been used lately, but not long enough to fully test its lasting qualities. It has ample strength and is free from welding seams, one of the defects in wrought iron and steel pipes of small diameter. There is little or no record of its effect on health, but there is some prejudice against its use. In cost, heavy brass pipe compares favorably with AA lead and costs less than AAA lead. Pure copper pipe can be had at about the cost of AAA lead. These estimates are based on the present market quotations for these materials, these being 10c per pound for lead pipe, 26c for brass and 28½c for copper. At these prices ¾-inch pipe would cost 35c per foot for AA lead, 47½c for AAA lead, 32c for regular brass, 42c for extra heavy brass, 37c for regular copper and 49c for extra heavy copper.

"With brass pipe the cost of joints would be eliminated unless the usual short connection used with iron and other rigid service pipes is still considered necessary. Whether the necessary flexibility to obviate settlement breaks can be secured without the use of the lead connection has not, so far as your committee has been able to learn, been worked out or tested."

From the chemical point of view the committee has been studying, through three chemists, the action of different characteristics of water upon lead and believes that a thorough investigation of the effect of the use of lead pipe on health should be made before it is recommended by the Society.

Charlestown Water Treatment Notes

In his annual report for 1922, J. E. Gibson, manager and engineer of the Water Department of Charleston, S. C., describes the use made by the department of the hydrogen-ion control method in connection with softening the water supply of the city, and also the use of caustic soda instead of hydrated lime. This section of his report is as follows:

"We have, for a number of years, been using hydrate of lime to restore the alkalinity of the water after filtration. In this process the water is hardened slightly. The raw water has an average hardness of about twelve parts per million, and when treated with alum and afterwards with hydrate of lime the hardness is increased to an average of twenty to twenty-three parts per million. This is considered a soft water by water works men; it is, however, considered hard by our people who are accustomed to the use of cistern water.

"In recent years, the hydrogen-ion or pH control method has been developed and used in determining the acidity or alkalinity of public water supplies. A neutral water is spoken of as having 'a hydrogen-ion or pH value of 7.'

"After conducting a series of experiments, we found that tests made in accordance with recognized methods to determine alkalinity, showed that the Goose creek water contained fourteen to twenty parts per million alkalinity; by the hydrogen-ion or pH method, it was slightly acid Hydrated lime being a weak alkali, we decided to conduct some experiments using a strong alkali, such as caustic soda to restore the alkalinity after filtration in an effort to increase the hydrogen-ion or pH value to or above the neutral point. We adopted caustic soda as being the more desirable alkali as it effects a greater reduction in the carbonic acid contents and also artificially softens the water.

"We began the treatment of the water with caustic soda on September 7th, and have continued it up to the present time. We find that it requires about two-thirds of a grain of 76% caustic soda per gallon to maintain the alkalinity at about eighteen parts per million and reduce the carbonic acid contents within two or three parts per million, as against approximately one and one-fourth grains of hydrated lime. The alkalinity in the filtered water has been maintained at the same point as measured by the erythrosine methods, and the hydrogen-ion or pH value has been increased from about six and six-tenths to seven and one-tenth, or an undoubtedly alkaline condition. The water has been artificially softened from an average of twenty-one parts per million hardness to twelve parts per million, or approximately the same as that of the raw water.

"There has been a very great aesthetic improvement noted, in that as the calcium carbonate contents reacted with soap forming calcium oleates that are only partially soluble in water. These oleates curdle and settle at the water line of wash basins and bath tubs causing complaint. With sodium hydrate the reaction forms sodium oleates which are soluble, and therefore, this curdling has disappeared.

"The increased cost of the sodium hydrate treatment per day over that of lime, based upon a treatment of six million gallons of water per day, is approximately $16.00. Taking the generally accepted statement that it requires two ounces of soap to soften one hundred gallons of water for each grain of hardness per gallon, expressed as calcium carbonate, and that one-tenth of the total water supply is softened for laundry, domestic and manufacturing purposes, and that on an average we soften the equivalent of one-half grain of calcium carbonate, the total soap and boiler compounds saved per day would be six thousand ounces or three hundred and seventy-five pounds. Further, if the average cost of soap is eight cents per pound, we have a gross saving to the consumer of $30.00 per day, as against an increased cost to the Department of $16.00 per day. There is undoubtedly a fur-

ther indeterminate saving in that with the higher hydrogen-ion or pH value obtained with sodium hydrate, there is a reduction in the corrosive action of the water on the mains, and there is the aesthetic value, in that the curdling with soap is almost entirely eliminated."

Benton Harbor Purification Plant

Recently completed plant that contains some unusual features and treats both river and well water, which carry different percentages of iron. Work done by city-paid labor, under a contractor as superintendent.

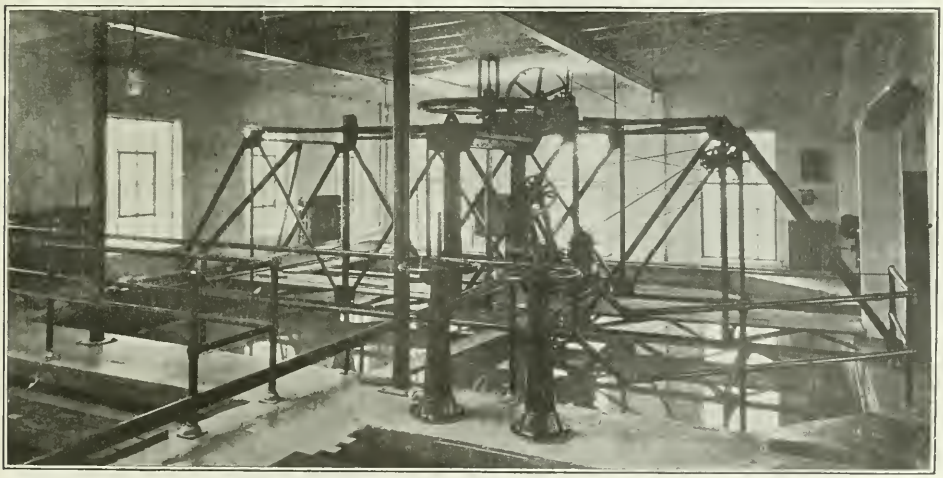
The city of Benton Harbor has recently completed a water purification plant which contains several features of unusual interest, one of which is the overdosing with chemicals of a part of the water only and later a combination of this with the entire supply; another is the use of a Dorr thickener, it being believed that this is the first instance of such use in a water works plant.

The plant was designed at first for treating St. Joseph river water, which was intended to supplant that previously obtained from twenty-seven 6-inch wells, the supply from which had become inadequate. However, at the suggestion of the engineers the city commission decided to use the well water up to its capacity and supplement it with river water in times of high consumption, the principal object being to maintain a supply of cool well water as long as possible.

The waters are essentially different, the well water being bacteriologically pure, but containing an excessive amount (two parts per million) of soluble iron salts and considerable hardness, but the river water, while nearly as hard as the well water, contains no iron and does contain harmful bacteria. The problem was therefore one of building a plant adaptable to treating two types of water, removing the objectionable iron and also hardness in the well supply and bacteria and hardness in the river water.

The physical features of the new plant consist of a concrete intake crib in St. Joseph river connected by 1,200 feet of 14-inch cast iron pipe to a concrete well 12 feet in diameter and 17 feet deep; a remodelled pump room containing two 2-million-gallon simplex, double acting, compound piston pumps made by the Union Steam Pump Co., for low-lift service, and one Worthington 2-million-gallon duplex, double acting, compound, piston pump, and two old 1½-million-gallon Hughes duplex pumps that had been in constant service for 31 years and were completely overhauled; three old 75 h. p. fire-tube boilers, which received no repairs; and the water purification plant.

The water purification plant comprises five concrete mixing chambers with propeller agitators, two of them about 8 feet square and three about 14 feet square, and all 18 feet deep; three dry feed chemical machines, two for hydrated lime and one for alum; a Dorr thickener with concrete tank 29 feet in diameter and 14 feet deep; two coagulating basins, each 29 by 87 feet by 18 feet deep, with a capacity of 325,000 gallons; four filter beds, each with a rated



DORR CLARIFIER—FIRST INSTALLATION IN A WATER FILTER PLANT.

capacity of 500,000 gallons per day; one clear water reservoir 87 feet by 108 feet by 12 feet deep, with a capacity of 750,000 gallons, and one 40,000 gallon elevated steel tank, 59 feet high, for storing wash water. A two-story brick filter house covers the pipe gallery and filter operating floor and contains storage space on the top floor for 100 tons of lime and 50 tons of alum. On this floor also are the engineer's office, testing laboratory and toilet. A hydraulic elevator facilitates handling material. Smaller apparatus includes chlorinating equipment, marble filter operating tables, a 14″ x 7″ venturi meter and an 18″ x 9″ venturi meter, rate controllers and loss-of-head indicators on each filter, a depth gauge for the clear water basin, and necessary pipe, fittings, valves, etc.

In designing the plant great flexibility was aimed at so that well water and river water can be treated separately or mixed as desired.

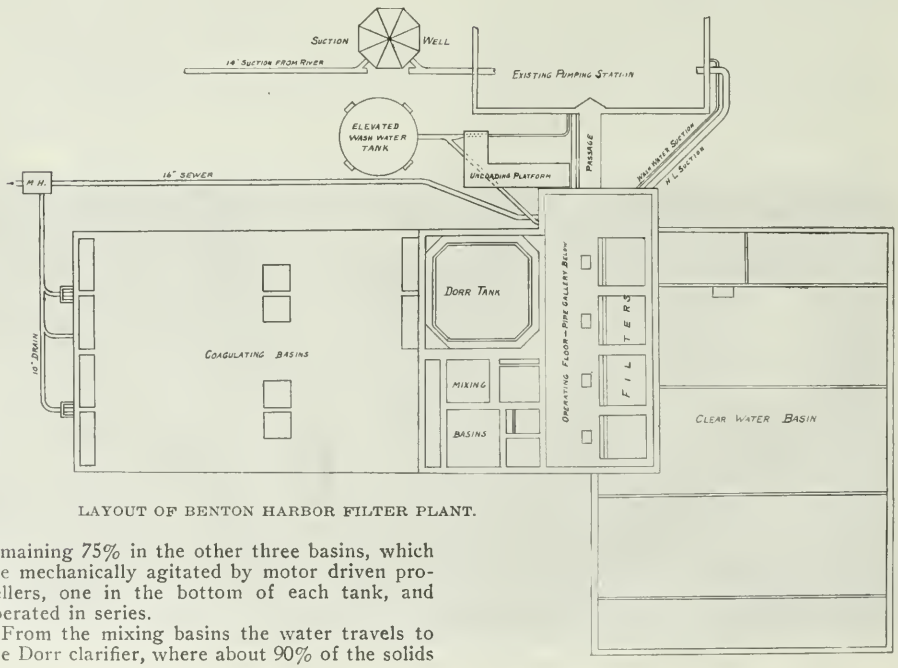
The plant has a rated capacity of two million gallons per day. Water is raised by the low-lift pumps into five mixing basins. The two 8-foot basins receive 25% (or any other desired proportion) of the total raw water flow and to this is applied the full dose of lime and it may receive return sludge from the clarifier, and alum or sulphate of lime if desired. The three larger basins receive the remainder of the raw water. The charge of the chemicals into the 25% of the water produces a quick reaction and large floc. After a retention period of about 45 minutes this overdosed portion is mixed with the remaining 75% in the other three basins, which are mechanically agitated by motor driven propellers, one in the bottom of each tank, and operated in series.

From the mixing basins the water travels to the Dorr clarifier, where about 90% of the solids is removed by continuous operation. Some of the sludge from this tank can be returned to the first mixing basin and there recirculated and assist in the agglomeration of the floc, or all can be discharged into the sewer. Provision is made for applying alum at the outlet of the Dorr clarifier. (Since writing the above we have been informed by Pearse, Greeley and Hansen, the engineers, that practical operation of the plant has shown that there is no advantage in over-treating one-quarter of the flow for softening purposes, because of the fact that the water contains considerable magnesium and it has proved undesirable to add enough lime to any portion of the water to precipitate the magnesium hardness. In other words, a somewhat better efficiency is obtained by adding the lime to the whole body of the water. The return of sludge from the Dorr thickener, however, is proving very useful in agglomerating the precipitate.)

The Dorr effluent goes through two sedimentation basins in series. From the second of these the water travels onto mechanical filters of the usual type and thence into the storage reservoir.

When operating at the rate of two million gallons per day, the detention periods are three-quarter hours in the mixing basins, about one hour in the Dorr clarifier and eight hours in the two sedimentation basins.

The intention is to remove practically all of the iron and part of the temporary hardness as well as a large percentage of the bacteria. No effort is made to remove any of the permanent



LAYOUT OF BENTON HARBOR FILTER PLANT.

VIEW OF PLANT, LOOKING NORTHWEST.

hardness nor all of the temporary hardness, but the reduction will be approximately from 225 parts per million to 100 or 125 parts, which will bring it about the same as Lake Michigan water. The calcium or magnesium bicarbonates and the iron bicarbonates combine chemically with hydrated lime and settle out in the clarifier and sedimentation basins. Aluminum sulphate is used as a coagulant.

Attention is called by the engineers to the possibility that if raw water be turned onto the sand filter it may deposit iron on the sand grains and this therefore is warned against. It is also suggested that, should mono-carbonates deposit on the sand grains of the filter (which, however, is not expected to occur), it may be desirable to inject carbon dioxide gas into the water before it goes onto the filters, which will render the carbonates soluble and prevent their being deposited in the filter. It is also suggested that it may be desirable to aerate the water to remove odors, tastes or color and that this can be done at a moderate cost by building an aerator on top of the coagulating basin and connecting the raw water line in the pipe gallery to this.

PIPE GALLERY.

The piping and valves are so arranged that the mixing basins, the Dorr tank and the coagulating basins can be by-passed separately or together if desired. The filters, however, cannot be by-passed nor can the entire filter plant.

The chemicals are supplied by dry feed machines and the feed pipes are so arranged that lime and alum can be applied at several different points, which may be desirable at different periods with different rates of operation and treating different waters.

In their report to the city, the engineers stated: "Each filter operator should endeavor to learn as much as he can about filtration and about this plant in particular, so that full advantage can be taken of all the mechanical features provided, such as by-passes, chemical feeding and operation on the sand filters. This plant presents many interesting problems to an experienced water chemist and engineer and if intelligently operated can help answer several questions which have been in water works men's minds for some time. In this way the city will be advertising itself and assisting the profession in general."

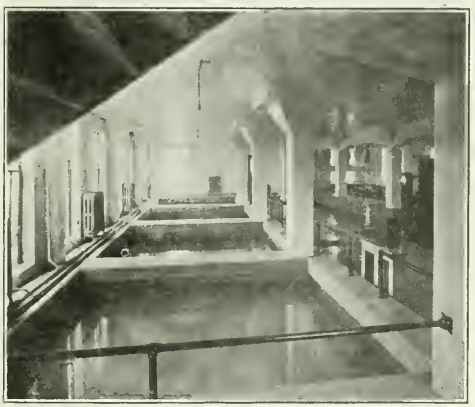
Dr. A. M. Buswell, chief of the State Water Survey of Illinois, assisted in starting the chemical control of the plant, and furnished for operator a chemist who had studied under him at the University of Illinois, which will apparently assure unusually good chemical control of this plant.

The plant is now using about 9 grains of hydrated lime and ½ grain of alum per gallon. No soda ash is used. This gives a reduction of about 50% in hardness and removes all of the iron. A reduction of 90% of suspended solids obtained by the Dorr thickener was shown possible by preliminary tests and for this reason it was decided that it would not be necessary to use as large settling basins as had formerly been the practice.

CONSTRUCTION

In January, 1922, there were many idle men in the city and largely for this reason it was decided to begin construction at once, and the work was inaugurated on January 18. Authorization had not been obtained to proceed with the entire plant and plans had been prepared for a clear water basin only.

The basin was built inside a cofferdam, consisting of triple 2-inch by 12-inch planks 18 feet long, supported by round piles. As the soil was almost pure sand and ground water stood within



FOUR FILTER BEDS, OPERATING FLOOR AND, AT RIGHT REAR, THREE CHEMICAL DRY-FEED MACHINES.

two or three feet of the surface, excavation was very difficult and costly. It was started by hand, but a crane was put in later. To prevent the completed basin from floating, due to high ground water, it was designed to carry four feet of earth on top of it. This structure was completed June 10.

From then on it was a race between plans and construction work. Authorization to proceed with the plans for a complete plant was received only two weeks before actual work started on the new portion. This was an unsatisfactory method of procedure and presented some difficulties, but was the only one possible under the circumstances. The coagulating tanks, mixing basins and Dorr tank were finished about August 20 and the filter boxes on September 20.

All of the excavation, concrete work, intake, building, exterior piping and miscellaneous work was done under J. M. Allmendinger, a local contractor, as superintendent, under an agreement with the city by which the latter furnished all material and paid all labor bills, while the contractor served as superintendent and furnished the use of his equipment to the city for a fixed fee. The engineers report that Mr. Allmendinger on the whole did his work well and tried conscientiously to save the city as much money as possible.

On August 10 separate bids were received for constructing a two-story building and its furnishings, and for installing filter equipment. Only one bid of $27,000 was received for the building and this was rejected and the work done by Mr. Allmendinger under the arrangement above described. Several bids were received for the filter equipment, the lowest being by the Norwood Engineering Company at $21,325 and the next the Roberts Filter Company, $300 higher. The contract was awarded to the former, which began work on October 19 and completed it on April 1, 1923.

Work on the river intake was held up all summer because of the delay in receiving a permit from the government. This was finally received on September 12 and work started on October 10. A cofferdam of 2-inch by 12-inch by 22-foot triple sheeting was put in the river during construction of the concrete crib. There are two lines of 14-inch cast-iron pipe between the crib and the valve box on shore, a distance of 275 feet. These pipe lines are installed in the river bed on timber saddles carried by pairs of round piles spaced 12 feet apart. These iron pipes were leaded together in lengths of 137 feet above water, suspended from the pairs of piles and lowered onto the saddles by ropes, and the joint between two such lengths was made under water by divers using lead wool. This work was made difficult by quicksand on the river bottom and it was impossible to complete it before cold weather set in, and it was carried on intermittently during the winter, but at greatly increased cost and difficulty because of cold weather. One line was completed November 15 and both lines were finally connected up on April 16, 1923. Water was put into the plant from the wells on March 25 and filtered well water was pumped to the city on March 30, while river water was first pumped on April 28.

Meantime the old pump room had been remodelled and cleaned up, two new low-lift reciprocating steam pumps installed, the old high-lift pump completely overhauled, rebored and renewed, and a new Worthington duplex pump put in. While the pumping plant has been greatly improved, it is realized that is not on so efficient an operating basis as could be obtained with a new plant and the engineers recommend that the installation of new water-tube boilers and high-duty pumping engines be kept in mind, to be adopted as soon as the money is available.

COST OF PLANT

Up to April 21, 1923, which saw the practical completion of the plant, the city had paid out for labor $63,603 and for material $82,750, while the contractor's fee was $10,000. The two new low-lift pumps cost $3,556 and the high-lift pump cost $4,000, while the Norwood Engineering Company received $21,325 for its filter plant. Adding $14,200 for engineering, etc., gives a total of $199,434.

Analysis of the costs shows that the average cost per ton for placing steel was $24.17 and for placing cast-iron pipe $27.60. In constructing the filtered water basin, the labor cost on concrete work per cubic yard was $3.03 on the floor, $3.54 for forms and $3.61 for concrete in the walls, and $4.40 for forms and $3.67 for concrete in the roof. In the sedimentation basins, Dorr tank and mixing basins, the cost (per cubic yard of concrete) for forms was 59 cents for the floor, $8.24 for the walls and $10.09 for the roof, while the concrete cost $3.29, $3.24 and $7.04 for these three parts of the construction respectively. Forms for the filter box cost $5.69 per cubic yard and the concrete $2.51. For the building, the forms cost $15.60 and the concrete $10.96 per cubic yard, and laying brick cost $33.98 per thousand. The above are all labor costs only.

The filtered water basin contained a total of 962 cubic yards of concrete, of which 326 was in the floor, 241 in the walls, 280 in the roof, 55 in the parapet wall and 60 in the columns and base. The coagulating, Dorr and mixing tanks contained 978 cubic yards of concrete, 280 in the floors, 546 in the walls and 152 in the roofs. There were 168 yards of concrete in the filter box and 176 in the building. The total amount of concrete in the plant was 2,284 cubic yards.

In addition to the concrete, there were used in the job 232,000 pounds of reinforcing steel, 317,800 pounds of cast-iron pipe installed by the city and 45,000 pounds by the Norwood Engineering Company. There were also 92,000 brick.

The engineers were Pearse, Greeley and Hansen, of Chicago. The resident engineer was H. D. White, to whom we are indebted for the above information. The city manager is Guy Tyler.

New Sewage Disposal Installations

Among questions submitted by us to city engineers in our latest sewerage questionnaire was: "Do you expect to build a new sewage disposal

plant?" The majority of the cities, of course, replied in the negative, but 71 replied that the construction of new sewage disposal works was either under way or contemplated.

Of this number two stated that a treatment plant had been completed this year, and 12 that such plants were under construction. Four replied that plans had been prepared or were being prepared. Eighteen stated that they expected to build such plants, 20 that they expected to build them, but would not do so this year; while 15 stated that such plants would probably be built, or, in some other terms, indicated that no final decision had yet been reached.

Garbage Disposal in St. Louis

Garbage disposal during past eighty-four years. Description of incinerator built last year.

After several years of discussion, experiments and public criticism, the city of St. Louis last year finally decided upon a method of disposing of its garbage, which is believed by the mayor, the board of aldermen and the director of streets and sewers to be the best available.

The plan decided upon is to locate four or five incinerators, one for each district of the city, with a view to minimizing the length of haul. One of these has just been completed, located on the bank of the Mississippi river a few blocks from the heart of the business district. The contract for this plant was let on May 19, 1922, for $69,812 to the Chicago Incinerator Company of Chicago.

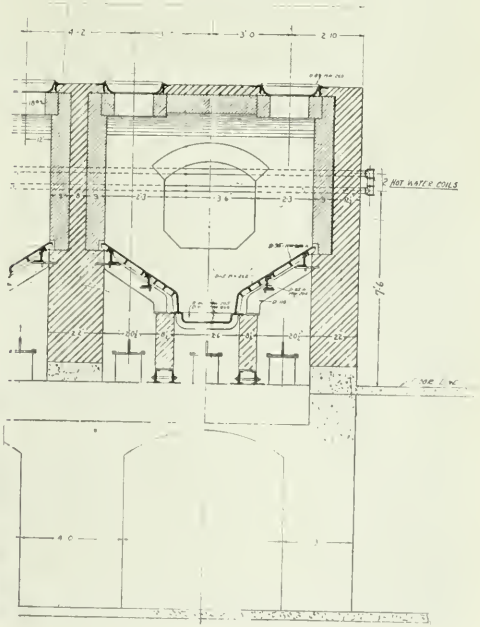
HISTORY OF GARBAGE DISPOSAL IN ST. LOUIS

The Municipal Library of St. Louis informs us that the first ordinance relative to garbage was passed in December, 1839, requiring the city marshal to let at auction the removal of kitchen slops and dead animals. Amendments to this and new ordinances appear on the records at frequent intervals, numbering 47 in all. Contracts were let to different parties for the removal and disposal of the garbage, generally by dumping into the river until this was prohibited by the Federal authorities. In 1901 the St. Louis Sanitary Company contracted to dispose of the garbage by means of the Merz process, which party retained the contract for a number of years. In 1908 a contract was entered into with the Standard Reduction and Chemical Company for disposal of garbage in a plant on the Mississippi river outside of the city limits. This was for 10 years, but was abandoned by the contractor in 1913, when the city contracted with the Indiana Reduction Company to dispose of garbage delivered to it at receiving stations for 87 cents a ton, the previous contract having been for 27 cents a ton. In 1917 a contract was made for a Hirsch garbage reduction plant with a guarantee that the by-products would net about $3.60 per ton above operating expenses, the city advancing $17,000 for a test of the plant. This plant was partially constructed, but never used and the city recovered $15,000 on the contractor's bond. Other contracts were made in 1918, 1919 and 1920 with different parties, the 1920 contract involving removal of garbage to a point 62 miles south of St. Louis, the city paying 50 cents per ton and the freight.

In 1922 a contract was let for removing garbage to be delivered by the city to barges in the river, the contractor being paid $1.60 per ton. This contract was subject to cancellation at 90 days' notice. It is understood that some of this garbage is sold to farmers at the rate of 60 cents per ton, for feeding hogs. On February 15, 1923, a one-year contract was made with practically the same terms but paying $2.10 per ton.

The garbage collected during 1922-1923 totaled

ST. LOUIS INCINERATOR UNDER CONSTRUCTION.



ONE OF THREE FURNACES OF THE NEW ST. LOUIS INCINERATOR.

68,354 tons and cost $3.55 per ton for collection and $1.60 per ton for disposal, or a total of $5.15. Also, 11,857 dead animals of all kinds were disposed of. At present about 80 tons per day is being hauled to the incinerator plant and the balance is being delivered to the previous contractors on barges adjacent to the incinerator plant, by which it is carried down the river as above described. During the summer there are about 130 wagons in service hauling garbage. The wagons used weigh about 2,500 pounds and hold about 1 1/4 tons of garbage. Experiments are now being made with truck and trailer for hauling and this has reduced the cost of collection, but has not eliminated the mule-driven wagons.

It has been recommended that there be ultimately five incinerators, three of 100 tons capacity on the river and two of 150 tons capacity in the western part of the city, which will greatly reduce the cost of collection. During the summer the incinerators will probably be operated 24 hours a day, but only 8 hours per day in winter.

It is proposed to require that all garbage be drained and wrapped in paper, thus increasing the efficiency of the incinerator plants and obviating the hauling of sloppy garbage through the streets. It is also believed that all the hotels and large apartments should be required to put in their own incinerator plants.

THE NEW INCINERATOR

The incinerator built last year by the Chicago Incinerator Company is housed in a brick structure of fine appearance, two stories in height, with a chimney 125 feet high and entered by a ramp or runway which leads to the second floor. This plant was completed in October and burning of garbage begun on October 29th, and it has been in operation ever since. The original guaranteed capacity of this incinerator was 80 tons per 24 hours, but following a few weeks of operation some changes were made by which the capacity was increased to 104 tons.

The building is 57x38 outside dimensions and the ramp is a timber trestle about 300 feet long. There is a foundation consisting of 49 20-foot reinforced pre-cast concrete piles. The roof is supported by steel trusses. The radial brick chimney is 5 feet inside diameter and is lined with 9 inches of fire brick for the first 50 feet and 4 1/2 inches for the next 55 feet.

There are three furnaces, each containing two dump holes, and horses or other large animals can be introduced through a separate intake without dismembering. Each furnace is 5 feet by 8 feet, and about 8 feet from the top of the arch to the bottom of the grate, or rather a substitute for a grate. The omission of grates is the most striking feature of this incinerator. The bottom of the furnace is composed of a cast iron pan 3 1/2 feet by 5 feet, from which rise sloping sides also of cast iron, the whole being supported by brick piers, the brick side walls and four beams. In these bottom plates are about 300 holes or tuyeres, through which air is forced for supporting combustion. Those in the inclined plates admit the air at a lower pressure than those in the center. This arrangement is said to permit complete combustion with the least amount of excess air. The forced draft is furnished by two centrifugal blowers, each operated by a directly connected electric motor, which take the air from the storage hopper, or else from the ash tunnel and passing through the clinker pits, to be described later. The three furnaces are connected to a common combustion chamber, from which a brick flue carries the flue gases to the chimney, the draft being regulated by a damper operated by a hand-driven worm gear.

On the second floor is a storage hopper which is built of reinforced concrete and provided with drainage. As stated, the air for forced draft is drawn from this hopper, which prevents odors from escaping from it into the outer air. The storage hopper is triangular in vertical cross section, 9 feet 6 inches deep, and has a capacity of 60 tons of garbage. Wagons discharge into it through three holes each 3 feet by 3 feet and three others each 18 inches by 4 feet. Coal is dumped from the tipping floor through two coal holes each 18x24 inches which discharge it on to the operating floor in front of the furnaces. There are six openings in the hopper, one immediately opposite each of the charging holes. The holes in the hopper are, when not in use, closed with steel doors operated by pulleys and weights, and the openings into the furnace are closed by cone shaped covers raised by pulleys. Beyond these openings is another steel partition, forming a so-called air-lock. A large door in this partition in front of each charging hole permits the operator to rake the garbage into it.

Under the furnace is an ash tunnel 5 feet wide and 9 feet high through which runs a track of 2-feet gage on which run the vehicles which remove the ashes. Immediately in front of each furnace, beneath the floor level, is a clinker pit into which the clinkers can be drawn from the furnace through a clinkering door and so into the pit, a gate over the pit at the floor level having been removed for this purpose. A passage through the furnace foundation wall connects the clinker pit with the ash tunnel, and the clinkers when cooled can be discharged from the clinker pit into the cars operated in the ash tunnel. The tracks in the ash tunnel lead out of the end of the building and to the river bank.

A perforated cast iron door closes the opening connecting clinker pit and ash tunnel, to permit the air from the ash tunnel to pass through the clinker pit into the blower intake, as described above. A small amount of coal is ordinarily introduced when necessary to aid combustion, the garbage drained being practically pure garbage with no other refuse mixed with it. The amount of coal used is said to be less than 100 pounds per ton of garbage burned.

On the operating floor there is an office 8x12 feet and a wash and toilet room 6 feet by 12 feet containing shower baths. The forced draft fans are operated by motors, one of 10 h.p. and the other of 20 h.p. The air for the forced draft is introduced to the fans through a 20-inch vitrified

pipe leading into a 3-foot by 6-foot dust settling chamber, and by the fans is discharged into galvanized ducts, one 18x24 inches and the other 18x36 inches, under the furnaces. Under each furnace there are three 12-inch holes in the ducts, two of which supply air to the side grates and one to the fire box, the supply of air being regulated by dampers over each hole.

The temperature of the combustion chamber is maintained at 1200 degrees and here all gases are supposed to be consumed. Dead animals are incinerated in the combustion chamber.

Two 2-inch pipes pass through all three furnaces near the top and are connected to a 280-gallon tank, which is thus kept full of hot water, which is used for washing the tipping floor, for cleaning purposes, and for heating by means of radiators in the office and toilet room.

In operating the plant the garbage is hauled up the ramp, weighed on scales at the entrance of the tipping floor and then is dumped into the storage bin, from which it is drawn as needed and charged into the furnaces. One of the charging openings is above each side of each furnace, and these are used alternately so that the garbage on one side may be burning while the fresh garbage is being dried on the other. After having been dried on the side plates, it is raked into the pan or fire box, where incineration is completed. The ashes and clinkers are then drawn into the clinker pit, where they cool off.

The contractors guaranteed that this furnace would incinerate 80 tons of garbage in 24 hours without any nuisance or malodors; that it would use per ton of garbage not over 8 k.w.h. of electricity for the forced draft fans nor more than 120 pounds of coal. C. S. Butts, engineer of the Department of Public Utilities of St. Louis, reports that "Tests show that this capacity has been raised to 100 tons in 24 hours and that it requires less than one k.w.h. for each ton of garbage and less than 100 pounds of coal per ton of garbage. The plant is being operated 24 hours per day in three 8-hour shifts, and requires three men on the firing floor, three on the charging floor and one foreman for each 8-hour shift, and is incinerating garbage without any offensive odors or smoke for $1.00 per ton, showing a saving of $1.10 per ton over the present contract for dumping it on barges at $2.10 per ton.

"This plant has been in operation for five months and as yet no complaint has been made against this method of disposal of garbage. After 84 years of garbage disposal troubles it is believed that the city has found the proper solution of the disposal of garbage in a sanitary manner." Clinton H. Fisk, director of streets and sewers, has charge of garbage collection and disposal in St. Louis.

Sewer Maintenance in Dayton

Cleaning by flushing, by machine, by buckets, wheelbarrows, horse-drawn scoop and other cleaning methods. Sewer gases. Annual cost of sewer maintenance.

By Ivan E. Houk*

Keeping the city sewers open, clean, and in repair at all times so that they are always ready for the maximum test is one of the municipal problems which has been receiving a great deal of attention in Dayton during recent years.

THE SEWER SYSTEM

Dayton, a city of approximately 160,000 population, has 128 miles of storm sewers and 263 miles of sanitary sewers. Fortunately the separate system of construction was adopted when the first sewers were designed. Therefore there is but one comparatively short section of trunk line sewer in the city which carries both storm and sanitary sewage.

The storm sewers proper, leaving out of consideration the open channels, both natural and artificial, vary in size from 15 inches in diameter to an arched section about 25 feet wide and 15 feet high. With the exception of this one arched drain, the largest storm main in the city is a 12-foot circular sewer. While Dayton has several elliptical and egg-shaped sewers, they are all smaller than the 12-foot circular section. The sanitary sewers, which are all circular in section, vary in diameter from 8 to 42 inches. Although catch basin laterals are generally laid with 12-inch pipe, no main storm sewers are laid with less than 15-inch pipe.

Both storm and sanitary sewers are now built of vitrified pipe if the diameter does not exceed 24 inches, double strength for those larger than 15 inch. Three-foot lengths and deep and wide sockets are used in the sanitary lines in order to reduce the infiltration through the joints. Sewers larger than 24 inches in diameter are now built of monolithic concrete, but formerly were built of brick.

MAINTENANCE OF THE SYSTEM

The work of keeping the sewers in serviceable condition is handled by the Bureau of Sewer Maintenance, a part of the Division of Engineering which, in turn, is one of the subdivisions of the Department of Public Service. From 25 to 30 men are employed constantly in replacing broken catch basins, raising and lowering manhole castings to conform to changes in street and alley grades, cleaning catch basins and manholes, flushing and rodding sewers, cleaning sewers, replacing broken joints of pipe, relining sewers

*City Engineer of Dayton, Ohio.

with the cement gun, inspecting and operating flood gates, inspecting new house connections, and so forth. Cleaning the catch basins, manholes, and sewers, constitutes about 75 per cent of the work of this bureau. Joe Madigan, superintendent of sewers, who furnished the writer with the greater part of the material contained in this article, is in charge of the Bureau of Sewer Maintenance and is directly responsible for its high efficiency. The writer is city engineer and George F. Baker is director of public service.

The basins, manholes, and sewers are cleaned whenever they need cleaning—not at periodic intervals. Some sewers have to be cleaned two or three times a year; others only once in two or three years. Sometimes sufficient cleaning is obtained by thorough flushing. Other times it is necessary to use sewer cleaning machines. Sanitary sewers can generally be kept open by flushing, except in cases where they are obstructed by roots or where considerable quantities of sand and gravel have gotten in through some opening. Of course, temporary stoppages caused by rags, clothes, and so forth, are removed by rodding. Small storm sewers, especially the catch basin laterals, are also frequently opened by flushing.

CLEANING MACHINES

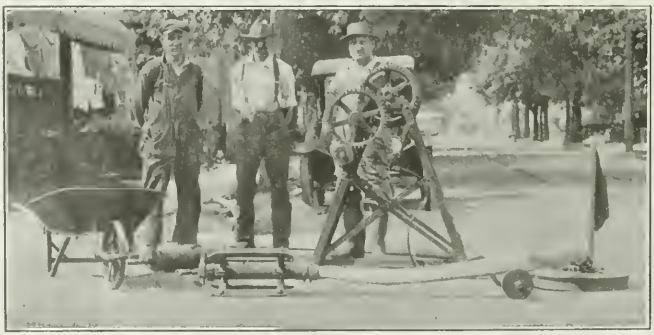
The turbine cleaning machine, a small hydraulic turbine with revolving knives, is used to open and clean the smaller sewers whenever satisfactory results cannot be obtained by flushing or rodding. This machine was purchased in December, 1919, at a cost of $1,515 f. o. b. Dayton, including accessories such as windlasses, braces, cables, clevises, clamps, sewer rods, both wooden and iron, forcing jack, pulleys, wrenches, extra knives, and in fact everything necessary for operation except the hose.

The machine itself consists of a small cylindrical barrel about 2 feet long, with four projecting arms near each end on which are mounted guides or runners which slide along the inside of the pipe. The turbine, with its revolving knives, is attached to the front end of the barrel; while the hose, leading to a hydrant which supplies the water under pressure, is attached to the rear end. A swivel clevis, mounted on the end of a rod projecting in front of the turbine, serves as a means of attaching a cable to the front of the machine. The machine is supplied with extra arms and knives of different size so that the turbine can be adjusted to fit all sizes of pipe from 6 to 20 inches in diameter. The 20-inch size can be used on sewers larger than 20 inches.

In operation, the wooden rods, which are 1¾ inches square by 3½ feet long, made of Oregon fir and fitted with malleable cast iron connections, are first pushed through the sewer from manhole to manhole. Then a small 3/16 inch galvanized cable is attached to the end of the rods and pulled through the sewer, drawing after it a ⅜ inch steel cable, the end of which is attached to the turbine, which has been lowered into the upstream manhole. A hose is attached to the turbine and a hydrant and a second cable attached to the rear end of the machine for use in pulling the machine back if necessary. The turbine is pulled slowly through the sewer by winding up the cable on the windlass at the downstream manhole, the knives revolving continuously as the turbine moves ahead, thus dislodging roots, cement, or other substances, and also washing the sides of the sewer thoroughly. As the turbine is pulled down grade, the water from it runs down the sewer ahead of the machine, thus carrying the detritus to the lower manhole, where it is caught by a small artificial dam placed at the downgrade side of the manhole, the water flowing over the top of the dam and leaving the solids on the floor of the manhole. The cables pass over pulleys, held in the manholes by suitable braces, to the drums on the windlasses above.

If the sewer is completely clogged so that the wooden rods cannot be gotten through from manhole to manhole, the turbine is placed in the lower manhole and forced upstream through the sewer by iron rods attached to the rear of the machine and pushed ahead by a worm geared jack.

Three men are required in this operation; one winds up the cable on the windlass, another feeds the hose into the manhole, and the third acts as a foreman and does whatever odd jobs may be required. The length of sewer they can clean in a day depends entirely on the particular conditions. If they can get the rods through without trouble, if the water pressure is sufficiently high, and if there is not too much sediment in the sewer, they can clean as much as three or four city blocks. The turbine has, in exceptional cases, been pulled through badly clogged sewers at the rate of 50 feet in 10 minutes,



TURBINE CLEANER CONNECTED TO HOSE READY FOR USE.

WINDLASS FOR OPERATING TURBINE.

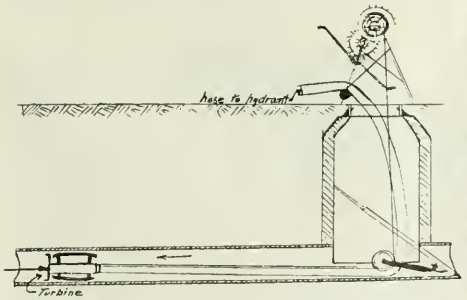
but an average day's work is slightly less than two city blocks, or about 500 feet. Since the foreman is paid $4.50 per day and his helpers each $3.40, the average cost per foot on this basis is approximately 2.26 cents. During the year 1921, 100,000 feet of storm sewers and 12,000 feet of sanitary sewers were cleaned with this machine at a total cost of $2,644.20, or about 2.36 cents per foot of sewer. This cost does not include the hauling away of the detritus, which probably does not amount to as much as a half a cent per foot, so that the total cleaning cost would be less than 3 cents per foot. Sometimes as much as three or four cubic yards of sand and gravel are taken from one block of 15-inch storm sewer. Considerable time is always consumed in moving to the job, setting up the equipment ready for work, and dismantling it at night.

A water pressure of about 50 or 60 pounds per square inch is necessary in order for the turbine to work efficiently. At 60 pounds it is supposed to deliver 3 horse power to the knives, which are supposed to revolve at about the speed of an electric fan. If the pressure is much lower, it is necessary to pull the turbine through the sewer two or three times in order to clean it properly. In such cases trouble is also encountered due to clogging of the knives. On the other hand, if the pressure is too high the knives may revolve too rapidly, and, in case they strike some solid substance such as a piece of concrete, may be either flattened out or broken off. An extra supply of knives of all sizes should be kept on hand at all times.

Unless special emergency work interferes, we operate our turbine continuously during from 6 to 9 months of the year. When cold weather arrives the work is discontinued on account of the freezing of the hose and the general disagreeable conditions connected with working in the water at such times. In the spring, when the weather becomes warm enough, the work is resumed.

In our experience in operating this machine under practically all kinds of conditions only a few minor difficulties have been encountered, such as must be expected with any kind of machinery. Sometimes, when the pressure was low, we have had trouble in cutting through roots, but with pressures as high as 140 pounds we have cut through roots an inch in diameter, and through masses of roots so dense as to be water tight, through pieces of concrete, bricks, tin cans, and so forth.

Another type of sewer cleaning machine which Dayton has used is a bucket machine known as the Stewart sewer cleaning machine. We have machines of this make, one purchased in 1906, the other between 1908 and 1912, each costing $750. I understand that the later models have been much improved. We do not use these often now, and seldom on sewers larger than 24 inches in diameter. The bucket machines have the advantage over the turbine in that some of the finer material is always washed over the dam when the turbine is being used. The principal use we make of our bucket machines at present is to loan them to contractors to clean out new sewers that they have constructed.

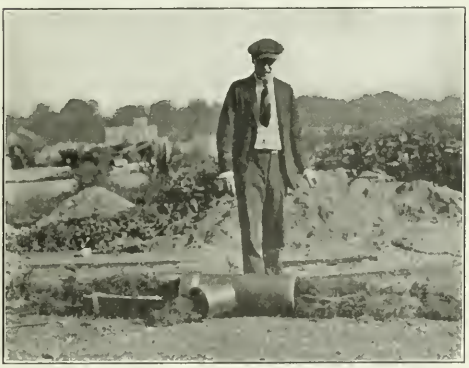


SEWER CLEANING APPARATUS USED AT DAYTON.

OTHER CLEANING METHODS

Sewers which are large enough for men to enter are cleaned by the use of buckets, shovels, wheelbarrows, and windlasses. Sewers as small as 30 inches in diameter have been cleaned by crawling in them, scooping the sediment into small buckets, and dragging the buckets to the manholes, where they are lifted to the street by hand. If the sewers are large enough for the men to walk in, the debris is loaded on wheelbarrows, wheeled to the manholes, and then hoisted to the street level in large buckets by windlasses attached to substantial tripods. In the summer of 1922, 428 yards of gravel were removed from the Lorain avenue storm sewer by such methods at a total cost of $2,240, or approximately $5.23 per cubic yard, including the hauling away of the material. In the summer of 1916, 1,700 cubic yards of mud, sand, and gravel were removed from the Lorain avenue and Parrott street storm sewers by similar methods, but unfortunately no data on the cost of the work are available.

These two sewers, both built years ago, furnish examples of poor sewer design. The Lorain avenue sewer comes down from the comparatively high ground at the east edge of the city and changes abruptly from a grade of 2.70 per cent to one of 0.33 per cent, then to one of 0.18, and then to one of 0.12, the last continuing for a considerable distance. At the intersection of the 2.70 per cent and 0.33 per cent grades, which is at Parrott street, the section changes from a 5-foot brick to a 6.5-foot brick sewer and is joined by a 6.5 brick sewer from Parrott street. The Lorain avenue sewer is much overloaded


ROOTS FOUND IN AN 8-INCH SEWER.

while the Parrott street sewer is considerably underloaded. Consequently the water from the Lorain avenue sewer, which is loaded with mud and gravel from the unpaved streets to the east, backs into the Parrott street sewer and leaves a deposit of mud after each rain. The gravel is not carried into the Parrott street sewer because the velocity in that direction is not great enough to transport it, but is carried on down the Lorain avenue sewer and deposited in the section where the slope is only 0.12 per cent, where the velocity is naturally much reduced.

A few years ago a 300-foot section of a 9-foot circular storm sewer near the south edge of Dayton was cleaned by a horse hitched to a hand scoop. The section cleaned lies just above the outlet of the sewer, and the horse, which was blind, was led into the sewer, turned around, and led out again, loading the scoop and dragging it out of the sewer mouth.

Catch basins and manholes are cleaned by hand. An autoeductor was tried on the catch basins a few years ago and was found to work very well where the basins were filled with fine silt or mud. However, trouble was encountered when it was attempted to clean basins filled with sticks, twigs, and gravel, and by far the greater number of our basins become filled with such detritus rather than with fine material.

SEWER GASES

Sewer gases have not, thus far, required much consideration in Dayton. Complaints are frequently received from residents in different parts of the city saying that sewer gas is coming into their basements from the sewer, but upon investigation these cases invariably prove to be merely disagreeable odors from a cellar drain which has been connected to the sewer without being trapped and vented. Our maintenance men are working in the sewers throughout the city practically all the time, yet they have never encountered dangerous sewer gases except on one or two occasions when they were cleaning off the screens in front of the sewage pumps during a flood. We have had explosions in the sewers at times, but they have been due to leaks from the gas company's mains rather than to gases formed by decaying sewage.

Some trouble has been experienced with unpleasant odors escaping from the sewers into the streets. These have emanated from manholes at places where syphons have been constructed; from catch basins along our one combined sewer; from catch basins at intersections where by-passes have been installed from the sanitary to the storm sewers, to relieve the sanitary lines which are overtaxed by infiltration during heavy rains; and from manholes along the sewers leading away from packing plants. The undesirable conditions along the combined sewer have been relieved by replacing the old catch basins with new trap basins. Flap valves, installed in the by-passes, have achieved similar results. Nothing has thus far been done at the syphons, or below the packing plants, except to clean and disinfect the manholes and plug the openings in the manhole covers. However, we are considering installing vents to carry the foul air above the houses. These would be simply pipes running to the sides of the street and connecting with vertical pipes reaching several feet above the ground.

ANNUAL COST OF MAINTENANCE

The accompanying table gives, for each of the last eight years, the total length in miles of existing sewers in Dayton, sanitary and storm sewers being taken together, the total length cleaned by machinery, the total length cleaned by rodding and flushing, the total number of catch basins and inlets cleaned, the total cost of the sewer maintenance, and the annual maintenance cost per mile of existing sewers.

An inspection of the table shows that prior to 1919 the average maintenance cost per mile of existing sewers was about $58. In 1919 the cost more than doubled; and since that year the average cost has been about twice what it was before. The great increase in cost per mile in 1919 was due to the increase in wages and materials brought about by war conditions. In fact the scarcity of labor caused serious trouble during the year 1918, but owing to lack of funds, the difficulties were met by postponing some of the maintenance work until the following year rather than appropriating more money for that season's work. The large unit cost in 1920 was due to the great amount of repair work done that year with the cement gun. Several long stretches of sewers of from 6 to 9 feet in diameter, 5,241 feet in all, which were literally falling to pieces, were put in first class condition by relining with gunite and vitrified sewer liners. In some cases wire mesh was placed around the inside of the sewer and then filled and covered with gunite, thus producing a new reinforced concrete sewer inside the old section. The total cost of the cement gun repair work amounted to $15,000, so that the routine maintenance operations, such as make up the total cost given for the other years, was only $46,688, or $124.83 per mile. If this figure is inserted in the table for the year 1920 the maintenance costs per mile will show a gradual decrease since 1919.

It will be noticed that the average number of catch basins and inlets cleaned per year is 4,947, or nearly 5,000. Unfortunately accurate figures regarding the total number of basins and inlets existing in the city during each year are not available. The total number of catch basins existing at present is about 1,920, and the total number of inlets about 2,930, giving a combined total of 4,850. Consequently the total number of basins and inlets in Dayton are cleaned an average of once a year. Since it is necessary to clean the inlets only when they become clogged with sticks or some other debris, it seems likely that the basins are cleaned an average of at least twice each year.

Annual Cost of Sewer Maintenance in Dayton

Year	Total Miles Existing Sewers*	Total Miles of Sewers Cleaned — By Machinery	Total Miles of Sewers Cleaned — By Rod'g or Flush.	Basins and Inlets Cleaned	Maintenance Cost Total	Maintenance Cost Per Mile Existing Sewers
1915	339	——	56**	7,000	20,142	59.42
1916	348	1.24	70.29	5,480	19,551	56.18
1917	364	none	102.02	4,260	19,888	54.64
1918	371	none	29.83	2,619	22,810	61.48
1919	372	0.28	25.28	2,682	48,836	131.28
1920	374	3.77	24.50	5,280	61,688†	164.94
1921	381	21.21	26.04	7,500	45,202	118.64
1922	391	3.52	29.53	4,752	38,467	98.38
Averages			45.44	4,947		93.12

*Both sanitary and storm. **Total length cleaned, no record of length cleaned by machinery. †This includes $15,000 spent in repairing sewers with gunite.

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Convention Papers

For more than twenty-five years the writer has been attending conventions of societies that specialize in the construction and operation of public works—water works, sewers, highways, etc.—and has more or less faithfully sat through the sessions devoted to the reading and discussion of papers. And he has reached the conclusion that fully half that time was wasted.

Many, perhaps the majority, of the papers read at conventions are entirely unsuitable for that purpose, although as contributions to technical literature they may be excellent. We believe that the opportunity offered by the assemblage of numbers of specialists in a given branch of knowledge should not be wasted by asking them to listen to descriptions that could just as well—often better—be read by them at their homes; but advantage should be taken of the opportunity for comparing experiences and especially for discussing, face-to-face, controverted points of theory and practice with a view to reaching conclusions, clarifying ideas or broadcasting important developments.

In our opinion a paper, the reading of which is followed by applause only, without any discussion, might better have been read by the members at their homes. For only a few hours once a year these men have an opportunity of becoming acquainted, of personal interchange of ideas, and of receiving inspiration for more elevated professional ideals, and they should not be asked to devote these precious moments to the mere acquiring of more or less unimportant information that could equally well occupy leisure hours at their homes.

Papers that would serve their purpose equally well if published in the society's journal or in technical or trade periodicals have no place on a convention program.

Pumping Plants and Coal Shortages

A considerable part of the public water works plants of the country are absolutely dependent upon pumping in furnishing water to their communities and upon fuel for operating their pumps. Except in extremely cold weather, water is more essential to the health and life of human beings than is heat, and is much more so than trolley transportation or light. It would seem, therefore, that water should head the list of preferred consumers in the allotment of coal.

It seems probable, but not yet certain, that this winter will not see a repetition of the fuel scarcity of last, but in view of the importance of water supplied to communities no chances should be taken, but water commissioners and companies should press their claims for preference in the allotment and early delivery of coal.

In this connection it might be well to consider the substitution of other fuel, such as oil, and make detail plans ready for instant application if necessary. This was done last year by the Water Division of St. Louis, which changed its stoker furnaces at all pumping stations from coal to oil burning in 24 hours. A floor of fire brick was laid on top of the chain grates, flat-spray burners were installed, and the plants operated on oil for about three months. In this case the cost of oil was greater than that of coal per pound of steam evaporated, but by using oil the handling of coal and ashes is eliminated, the heat is more readily adjustable to varying demands, and there are other advantages. Only about half as much weight of oil as of coal would be required, which would be an advantage from the transportation point of view.

In view of the annually recurring threat of coal shortage it would seem to be profitable for water works superintendents to study carefully the substitution of oil for coal in their plants as a temporary measure, or even as a permanent one.

Oil Pollution of Navigable Waters

A conference is to be held on October 1st, 2nd and 3rd at Haddon Hall, Atlantic City, New Jersey, to discuss the growing nuisance and menace of the oil pollution of the navigable waters of the country and, in fact, of all civilized countries during the past few years. The conference is called by the National Coast Anti-Pollution League with a view to uniting against the oil pollution of coastal waters all the interests concerned, these including public health officials, port authorities, shell fish industries, hotel and resort owners, sportsmen and game protective associations, yacht clubs, fire underwriters, ship owners, water supply commissions and others. The remedy suggested is the passage of federal, state and municipal legislation prohibiting the discharge of oil, and international agreements to the same end; also the use by steamships of proper devices for separating oil refuse from waste water, or the provision of oil harbors or tanks.

Dedication of Don Pedro Dam

Another large dam to be used for irrigation purposes was dedicated on June 26th near Modesto, California, built by the Modesto and Turlock Irrigation Districts. In addition to furnishing water for irrigation, a considerable amount of electric energy will be generated by means of the dam.

This dam is known as the "Don Pedro." It is 283 feet high above the stream bed and 1,040 feet long, and will impound 290,000 acre-feet of water in a reservoir 14 miles long and covering 5 square miles. The dam is 16 feet wide at the top and 177 feet at the base and contains 281-550 cubic yards of concrte.

The Lighting of City Streets*

Considers especially secondary thoroughfares and residence streets. Location of light units and foliage interference.

Originally the function of street lighting was the prevention of crime, and as late as the eighteenth century it was dangerous for a person to travel the streets of almost any large city after nightfall without a bodyguard. Good street lighting has done away with this undesirable condition, so much so, in fact, that one is likely to forget the fundamental purpose of street lighting.

Another reason for street lighting which has always been more or less apparent is the facilitation of traffic. Especially is this true today when, with the ever-increasing amount of high-speed automobile driving, good illumination becomes more and more essential in the reduction of accidents. Statistics compiled as a result of exhaustive surveys indicate that a tremendous number of automobile accidents occurring at night are directly traceable to insufficient illumination.

The electrical industry has made an exhaustive study of the problems presented by satisfactory street lighting, and this has resulted in the improvement of the lamps designed for the purpose and the standards supporting the lamps. Scientific illumination of streets is now possible with a comparatively small outlay of money on the part of the municipality, and will at the same time be a most profitable investment from every angle. R. E. Greiner and Earl A. Anderson, two experts in the problems of street lighting, have done much constructive work in this field and much of the material contained herein is the result of their investigations.

While the fundamental reason for street lighting is the prevention of crime and accident, it has an equally important part in contributing to the comfort and convenience of the community. A satisfactory street lighting system not only makes possible the traversing of sidewalks and streets but effectively reveals inequalities in sidewalks and paving surfaces and makes walking both pleasant and safe. Even in less frequented locations a printed or written address is readable without striking a match; street signs are well enough lighted to eliminate the necessity of stopping to decipher them; house numbers are visible at a reasonable distance, and passing friends may be recognized on the streets in any part of the city. The goal of the street lighting plan, which is reasonably attainable without an undue expenditure, should be that the normal daylight activities on the streets may proceed at night practically without delay or increased difficulty.

In considering a plan of street lighting for a city, it is necessary to observe carefully the different requirements for each class of street to the end that the most efficient result possible may be obtained from the expenditure. The principal thoroughfares leading outward from the center of the city carry much traffic of a high-speed nature and must be lighted accordingly. In the residential streets, which do not carry through traffic to any great extent, requirements of illumination from the standpoint of traffic are, of course, much less severe. In some outlying districts appropriation allowances sometimes make it necessary to reduce the lighting to a system of small marker lights for corners only.

The thoroughfares leading out from the business center of the city have developed severe requirements for lighting under the new conditions of transportation. These streets carry high-speed traffic and are the location of a large percentage of street accidents, particularly at night in those cases where a proper provision for lighting has not been made. A fair provision for thoroughfares outside of the business

*Furnished through the courtesy of the Electrical Industries' Joint Committee for Business Development.

district is an arrangement of lamps, 600, 1000 or 1500 candlepower spaced from 150 to 250 feet apart, or at 300 feet as a maximum. If the street is very wide it may be necessary to consider each side as a separate street and provide lighting accordingly. The mounting height should be 20 or 25 feet in order to remove the bright light sources from the line of vision and to obtain a better spread of illumination. In the past, especially where there were wooden poles on the street, it has been common practice to use a lighting fixture suspended from a mast arm. This has the virtue of bringing the lamp over the street surface, causing the light rays to clear low-hanging foliage of adjacent trees. Bringing the lamp over the pavement also increases the possibilities of seeing objects by silhouette against the bright spot of light beneath the lamp or against the bright streak or glint reflections from the pavement. This is an especial advantage in the case of much traveled streets, which soon become blackened from oil but polished by wear and have a glossy surface when wet. Under these conditions a very large dependence must be placed upon seeing objects in silhouette against the glint from the pavement on account of the low level of general illumination.

Recent designs of street lighting equipment for thoroughfares and boulevards have shown the results of efforts to retain the efficiency of light distribution of this type of lighting and at the same time to obtain a construction which would add to the appearance of the street.

Where residence streets carry a large amount of through traffic they are in effect thoroughfares and should be lighted as such. In every city, however, there is a large percentage of street mileage not used for through travel and therefore not subjected to a large amount of high-speed traffic. Even in these streets, however, sufficient illumination must be provided to enable one to see objects and obstructions in the pavement when traveling at a moderate rate of speed. Illumination for sidewalks must also be provided of sufficient intensity to provide comfortable walking, and which does not leave such dark shadows behind tree trunks as might provide hiding places for footpads.

THIS FORM OF SUSPENSION ELIMINATES FOLIAGE OBSTRUCTION.
A 600 C. P., 20 Ampere Mazda Lamp.

Residence streets are usually well provided with trees, and unless the lamp in such cases is suspended over the center of the street, it is often necessary, to avoid a large loss of light, to use somewhat lower mounting heights than would be desirable on streets without trees. However, when 250-candlepower lamps are used they may be mounted as low as 15 feet above the curb without undue glare provided the light is properly diffused and directed. When larger lamps are used and at wider spaces, heights of 18 to 20 feet are considered preferable practice. In this matter of adequate height, the ordinary wood-pole bracket installations have been better than many systems of ornamental standards supplied from underground wiring. Some of these systems have used globes mounted on upright posts only 10 or 11 feet in height, and while tree foliage is successfully avoided the units are likely to prove very glaring in the eyes of drivers, pedestrians or of people on porches. Furthermore, a very close spacing must be adopted if all sections of the street are to be illuminated. Particularly on a curved road, glare from lamps placed too low may so interfere with vision that the lamps may actually become a source of danger to automobile drivers. In view of this, there is a tendency in recently installed systems to adopt a minimum height of

THOROUGHFARE AT HOUSTON, TEX., LIGHTED BY UNITS SPACED ABOUT 150 FEET APART, STAGGERED, AND 15 FEET ABOVE STREET SURFACE.

USED ON ONE SIDE OF STREET ONLY, SO MOUNTED AS TO PROVIDE SUFFICIENT LIGHT FOR BOTH SIDES.

15 feet for ornamental posts on residential streets. In addition, ornamental bracket designs have been developed which bring the lamp 16 feet or more above the street and with a bracket length of 4 or 5 feet to assist in clearing the foliage. When these equipments carry well designed refractor fixtures, the light utilization is as great as from the efficient but often unsightly wood-pole brackets.

The spacing of the lamps on residential streets varies greatly. Where overhead wood-pole distribution is used and the appropriation allowance is limited, spacings of 300 feet may be used to give fair lighting provided there are no trees to obstruct the spread of light. On the other hand, spacings of 100 feet or even less are not uncommon for underground distribution supplying ornamental units. Unless the interference from trees is excessive, spacings of 150 to 200 feet are found satisfactory. The lamps are usually staggered to eliminate as far as possible all tree-trunk shadows.

COST OF ADEQUATE STREET LIGHTING

A recent survey showed that fifteen years ago approximately 5.4 cents out of each dollar of municipal taxes was the average amount expended for street lighting in cities of 30,000 population or larger in the United States. In the face of the need for much better lighting, the amount allotteed for street lighting for the same cities in 1919 had fallen to an average of 3.8 cents. In an article commenting upon this relatively small expenditure for this essential public service, one author reported that the average per capita expenditure in cities is only about 70 cents annually for street lighting. The highest reported was $4.81 per capita, and in fifty of the best illuminated cities there was an average of $2.04 per capita.

It probably is not sufficient to compare street lighting expenditures on the basis of population alone, since in cities having the same population there may be considerable difference in the number of miles of improved streets. Possibly a fairer method of comparing street lighting appropriations is to base the computation on the basis of paved streets. But even on this basis there are several variables which should have weight. Some of these are the layout of the city, the width of streets and intersections, the amount of foliage, the character of street paving, whether current is distributed overhead or underground, and the local cost of labor and materials entering into construction. The following tabulation, however, indicates the order of annual cost per running foot of street:

Class of Streets	Annual Cost Per Foot of Street
Business district	$1.00 to $4.00
Thoroughfares, mfg. dists., blvds.	.25 " 1.00
Residential streets	.15 " .60
Outlying districts and alleys	.05 " .20

The lower range of figures applies to systems involving a minimum outlay for installation, and in general providing minimum levels of illumination. The upper range of expenditure in most cases permits an adequate installation consisting of underground distribution supplying ornamental lamp standards of substantial design and properly placed to obtain maximum effectiveness of illumination.

The initial investment for installation of circuits and equipment is a factor which affects the design of street lighting in a greater measure than it does interior lighting. Especially where the service to the lamp is carried underground, as is becoming more and more the practice for new installations in progressive cities, the fixed charges on the investment for equipment may actually form half the annual cost of the system. The actual cost of installing the ducts and cables, the cost of lighting standard and fixture, and some of the costs of maintenance, such as cleaning and repair to equipment, increase but little for the larger sizes of lamps as compared with smaller. There is consequently a distinct economy in cost per unit of light by adopting the larger lamp sizes.

In view of the insufficiency of municipal appropriations, it became quite common several years ago for individual groups of property owners to install sections of improved street lighting with ornamental equipment at private expense. Because of the difficulty, however, of insuring a continuance of proper

UNIT SUSPENDED FROM MAST ARM BRINGS LIGHT OVER SURFACE OF PAVEMENT.

G. E. Novalux, two units with prismatic refractors.

maintenance under this plan, and also because of the recognition of the importance of this lighting as a municipal improvement, present practice is very distinctly in the direction of having cities handle contracts for the installation and operation of all street lighting. Particularly in business districts, the city may assume the entire cost of the system in view of the benefit accruing to the city as a whole. In other cases a large part of the cost of special lighting may be charged back to abutting property under the laws in many States, which permit the establishment of special improvement districts in which assessments are made for the street lighting in the same manner as for the paving and other necessary street improvements.

Hill-to-Hill Bridge*

Continuation of description of construction methods employed in the construction, now nearing completion, of a six-thousand-foot viaduct at Bethlehem, Pennsylvania, described in the July issue.

FORMS AND FALSEWORK

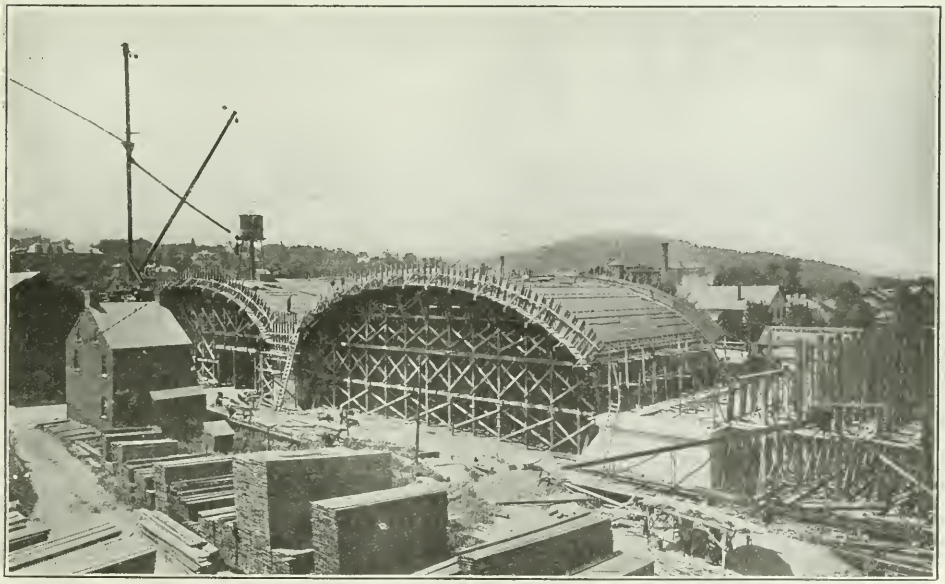
The 1¾-inch transverse lagging planks for the arch spans of the main bridge were nailed to 27 lines of 3x12-inch bows breaking joints on the center lines of 8x12-inch transverse caps from about 6 to 8 feet apart. At the ends of the spans these caps were generally supported on transverse framed falsework bents and in the centers of the spans they were carried on short vertical posts that were seated with wedge adjustment on 10 lines of longitudal stringer caps scabbed to the vertical posts of the falsework bents.

On the river piers small reinforced concrete brackets integral with the pier masonry were cast on the sides of the piers near the water level and firmly anchored to the pier masonry to support the lower ends of the vertical posts in the end bents of the false work. These bents, together with one or two adjacent bents that supported the haunches of the arch and the umbrella tops of the piers, were secured by permanent, horizontal anchor rods imbedded in the pier concrete and provided with end couplings close to the surface of the concrete which permitted the exterior extension to be removed and the holes pointed up after the erection had been completed.

Each of the 129-foot spans, 17-18 and 18-19 on the Main street branch of the bridge, has nineteen transverse bents, generally about 7½ feet apart. Each bent has ten 10x10-inch vertical posts, proportioned for 20,000-pound loads and assembled with 2x10-inch longitudinal and transverse diagonals and 4x10-inch scabs secured by ¾-inch bolts. Over Water street and over Monocacy creek, near the centers of their respective spans, open panels 15 feet wide in the lower tier of falsework, were spanned by 15-inch I-beams supporting the upper stories of the false-work. The mud sills were carried on 12 x 30-inch concrete footings.

The falsework for the 107-foot span, 6-7 of the main bridge, was supported in the center on a pier of the old bridge, formerly occupying the site of the present structure, and on both sides of the pier it was supported on pile and framed bents. The adjacent 107-foot span, 5-6, was similarly supported.

*Concluded from page 253.



FRAMED FALSEWORK, CENTERING AND LAGGING FOR 146-FOOT ARCH SPANS.

The 48-foot 10-inch span, 2-3, over two railroad tracks, has fourteen reinforced concrete girders, the forms for which were supported at the ends on framed falsework bents and intermediately on 10x10-inch transverse sills wedged up on the top flanges of 14 lines of 30-inch I-beams spanning a 32-foot 8-inch train clearance 18 feet high.

The sides and bottoms of the forms were generally made with 2x4 and 2x6-inch bevelled-edge planks except for the spandrel walls, which were of 1⅞-inch tongue and groove boards with 2x6-inch verticals 15 inches apart on centers and pairs of 3x6-inch waling pieces 3 feet apart vertically. The forms were braced when convenient by exterior inclined struts. For the arch ring they were braced to the projecting caps of the falsework, and were tied together by horizontal wires clearing the tops of the forms and extending across the full width of the bridge.

Pier forms and spandrel wall forms were tied with ⅝-inch permanent tension bolts having couplings at each end, permitting the removal of the end sections when the forms were stripped. The form bolts were all well oiled, to facilitate removal, and were twisted 180 degrees 12 hours after the form was concreted. The number of ties in the pier forms were proportioned to the height of concrete, sometimes as great as 25 feet, that was poured at once. The concrete in the spandrel wall sections was completed at a single pouring.

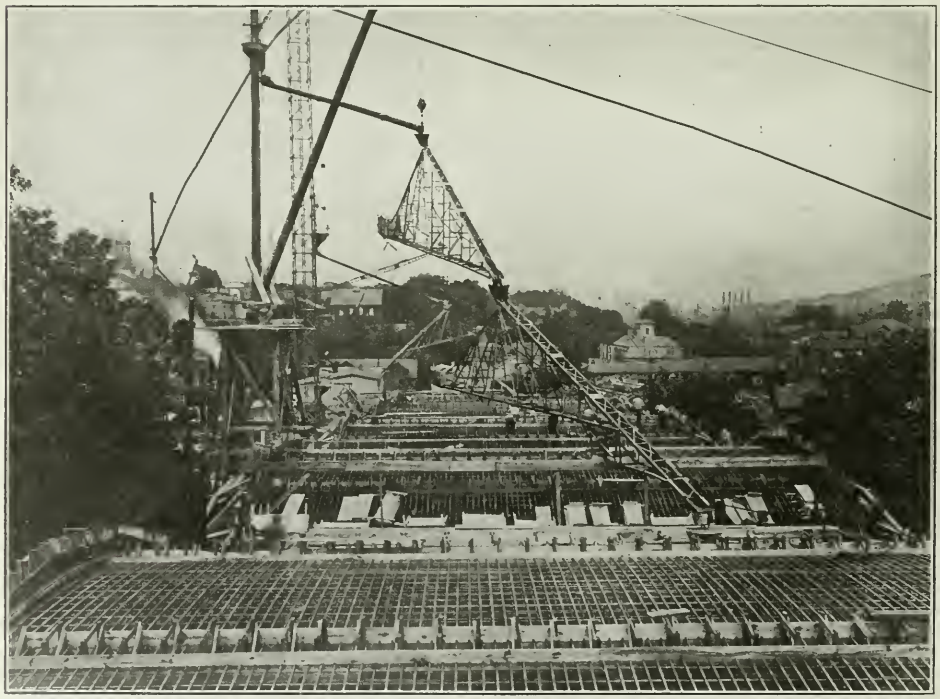
The fourth tier of ties from the bottom were anchored by permanent wire diagonal ties from the ends to resist floating by the buoyancy of the wet concrete. The ends of the lower tie rods were connected by very flat, transverse diagonals to anchor eyes imbedded in the arch rings to provide for adjusting and maintaining alignment.

The thicknesses of the arch rings at the ends were so great, and the pier forms were so large, that workmen entered the latter and very carefully spaded and rammed the wet concrete around the numerous reinforcement bars in the umbrella tops of the piers. The largest of these tops contained about 550 yards of concrete, which was continuously poured in one 24-hour operation. The end sections of the arch ring were concreted with top forms.

The permanent horizontal anchor rods in the pier masonry had end nuts bearing on vertical angles, built into the pier and arch rib concrete, which were secured by long, inclined back stay rods with nut bearings on the anchor plates at the lower ends.

The falsework, centering and vertical forms were accurately calculated and fully detailed on more than thirty-five large sheets of drawings, made for the contractors by Jackson & Moreland, Boston.

Concreting was commenced Dec. 14, 1921, and the work was discontinued on account of cold weather Jan. 11, 1922. It was resumed March 15, 1922. On July 1st, 1923 the work was about 75% com-



ARCH FORMS AND REINFORCEMENT READY FOR CONCRETING COMMENCED AT PIERS. BALANCED CANTILEVER CHUTES SUSPENDED FROM TOWER DERRICK.

pleted; all the piers except No. 2 were completed and 15 of the arches had been concreted.

PROGRESS AND QUANTITIES

The maximum amount of excavation made in one month was 9,480 yards. The maximum amount of concrete placed continuously in one form was 944 yards, spouted through chutes in 36 hours; the maximum quantity placed continuously in one form by buckets was 958 yards in 24 hours; the maximum quantity placed in one month was 8,723 yards.

The principal total quantities involved are: 64,000 yards of excavation; 100,000 yards of concrete; 34,550 yards of backfill; 49,400 yards of arch fill and ramp fill; 160,000 barrels of Pennsylvania Portland cement; 90,000 yards of broken stone; 60,000 yards of sand; 1,700 tons of reinforcement steel; 1,650 tons of structural steel; 500 tons of steel trolley tracks; 23,300 square feet of granite pavement; 230,000 square feet of 2-ply waterproofing; 180,000 lineal feet of electric conduit; 133 bronze lamps; 24,000 square feet of steel sheet piles; 2,000,000 feet of wooden foundation piles.

Great care was taken to use only the highest quality of cement. This was manufactured to standard specifications by the Pennsylvania Cement Company, inspected and tested at the mill and delivered from concrete bins to the automobile trucks that conveyed it to the bridge site. Concrete test cylinders are made almost daily.

The force employed June 1st 1923 aggregated 10 office men, 13 engineers and assistant engineers, 4 men on steel details, 17 chauffeurs and garage men, 15 mechanical and power men, 12 storeyard men, 20 reinforcement steel men, 84 carpenters, 66 carpenter's laborers, 50 concrete men, 20 concrete laborers, 28 quarry men, and about 60 other employees and 15 executives.

The bridge is being built for a lump sum price of $2,568,000.

IMPORTANT ITEMS OF PLANT AND EQUIPMENT

There were installed on this job, four Smith mixers with Troy vertical engines, automatic batch meters and watertanks, measuring buckets and charging hoppers; 12 Lidgerwood, 5 Clyde and 3 Lambert hoisting engines; 11 Lidgerwood and 3 Mead Morrison swinging engines; 6-1 yard Hayward orange-peel buckets, 3 Hayward, 1 Williams and 1 Owen clam shell buckets; 5 Kingsford, 2 Swaby, and 3 Lawrence centrifugal, motor-driven pumps, 4 of them with 10-inch suction pipes; 6 Cameron, 1 Buffalo duplex, 1 Worthington simplex, 1 Morris centrifugal and 1 Gould centrifugal steam-driven pumps; 5 Godfrey-Keeler, 1 Donegan & Swift and locomotive type steam boilers; 8 Burke, 1 Northwestern Manufacturing Co.'s, 2 Westinghouse, 5 General Electric, 1 Valley Electric, 1 Mechanical Appliance Co.'s and 1 Emerson Electric Motors of 3 to 100 horsepower; 13 stiffleg and 4 guy derricks with 45 to 80-foot booms; 5 McKiernan-Terry and 1 Vulcan pile hammers, 4 Ingersoll-Rand and 11 McKiernan-Terry sheeting hammers; 13 Ingersoll-Rand and 1 Cleveland rock drills; 2 Ingersoll-Rand gasoline driven and 1 Chicago Pneumatic Tool Co.'s steam driven air compressors; 1 Keystone steam drilling machine; 1 Osgood and 1 Marion steam shovels; 2 Gates and 1 Blake stone crushers; 19 stone screens, 26 Stuebner 1-yard and 1½-yard self righting dump buckets and 9 botton dump 1-yard concrete buckets; 2 cement bag cleaners, one of then driven by a ¾ horsepower electric motor; 2 cutting and welding torches; 1 Brownhoist locomotive crane with 52 foot boom; 1 Austin-Western Road Machinery Company's 12-ton gasoline road roller; 20 Pierce Arrow 5-ton dump trucks; 2 platform trucks, 2 trailers and one Stewart ¾-ton service truck; besides miscellaneous equipment and hand tools.

Water Power Development in North Carolina

Only a day or two after writing the editorial published in our June issue urging the advantage of cooperation between public officials and private individuals and companies, we received information of another instance of this advantageous cooperation, this time between state officials and public service corporations.

"The Southern Appalachian Water Power Conference is an organization of state commissions, public utility companies, engineers, bankers, industrial or commercial interests and individuals concerned with the development, operation, regulation and utilization of power projects and industries dependent upon them." Among the officials may be named Joseph Hyde Pratt, Director of the State Geological and Economic Survey, as president, a vice-president of the Southern Railway as vice-president, an hydraulic engineer as secretary, and the hydraulic engineer for the State Geological Survey as treasurer; while the executive committee includes a state geologist and a state forester, and officials of the Seaboard Air Line Railway, the Carolina Power and Light Company, the Columbia Railway and Navigation Company and the Georgia Railway and Power Company.

This conference aims to effect a more harmonious relation between public utilities, public service regulatory bodies, and the general public, establishing a bureau of public relations for this purpose. This bureau will prepare and disseminate accurate information concerning the development and availability of power. It will, when requested, act as mediator in disputes when these do not relate to rates.

It also proposes to establish a bureau of industrial development to furnish accurate information to industrial and commercial organizations, engineers, bankers, etc., obtaining this information by thorough investigation of the water powers, forests and other natural resources of the region, utilizing such information as had already been obtained by State Geological Surveys, conservation commissions and others. It will aim to serve as a general accurate source of information relative to the proper exploitation of the great natural resources of the South.

The conference also proposes to establish a bureau of research for compiling information relating to rainfall, run-off, power problems, natural resources, etc., now widely scattered, and carrying on investigations suggested by the conference.

It certainly gives promise of more amicable and mutually profitable relations between the public and

public service corporations when representatives of such corporations and of state governments cooperate in the development of public utilities that are of such vital importance to both. It offers hope that before long we will see municipal public service corporations and the taxpayers of cities meet each other in a friendly spirit of cooperation for the development of service which shall be satisfactory to the citizens and at the same time will yield to the corporations an income adequate to attract the necessary capital but recognized by the users of the service as being no greater than is justifiable.

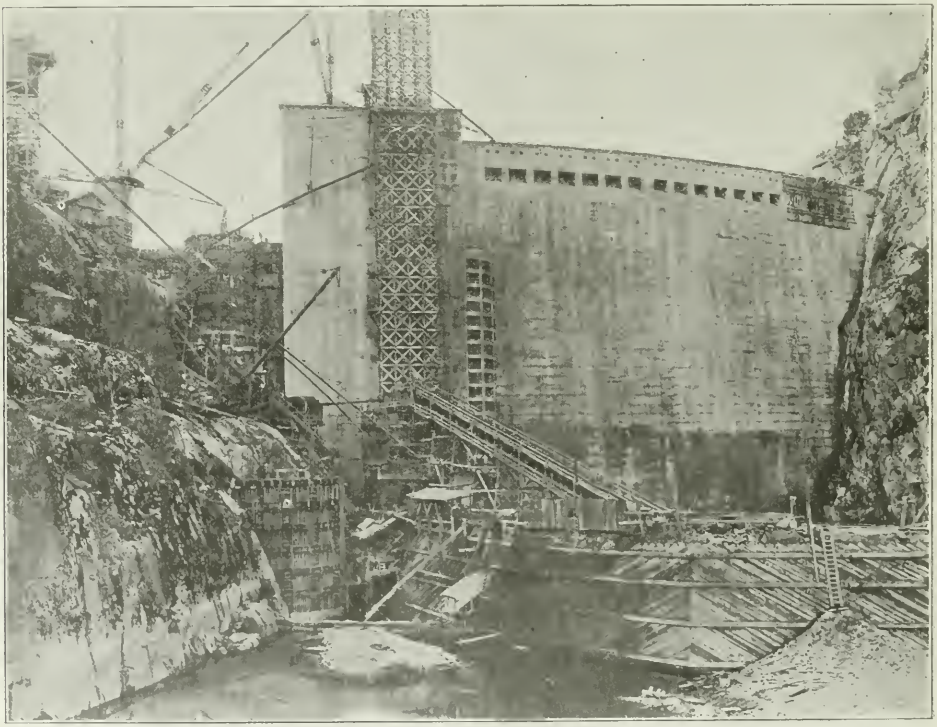
The Hetch-Hetchy Dam Completed

This dam, of national interest to engineers, has been officially named the O'Shaughnessy Dam. Its completion makes a prominent step in the consummation of San Francisco's ambitious program.

By CHARLES W. GEIGER

The City of San Francisco has just completed at a cost of $5,500,000 one of the largest masonry dams in the world, in connection with its Hetch Hetchy water and power project. Descriptions of this project have been given from time to time in *Public Works*. (See Sept. 21, 1918; March 6, 13 and 20, May 8 and 22, and June 12, 1920; July 8, 15 and 22, 1922). Now that it has been completed a brief description of the dam may be appropriate.

The structure is built in the shape of an arch with a 700-foot radius. It is 298 feet thick at the bottom. The foundation is 114 feet below stream bed and the crest is 227 feet above, making a total height from the foundation to the crest of 341 feet. The foundation is spread out with an offset 80 feet wide at the stream bed to provide for an addition in the



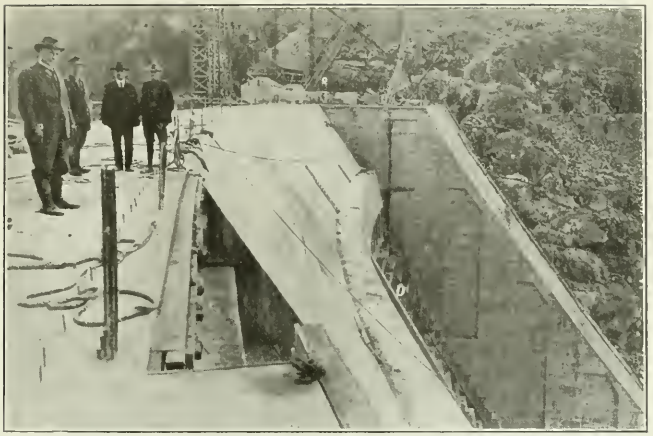
UP-STREAM FACE OF O'SHAUGHNESSY DAM.
Showing reinforced concrete screen racks which are built into towers attached to and constituting part of the dam.

future, which will permit another 85½ feet of height to the structure without excavating the stream bed. This addition will make it one of the largest masonry dams ever built. The dam is built with a siphon spillway, which will automatically hold the water level of the full reservoir constant within narrow limits. A roadway 15 feet wide runs along the crest of the dam, over the spillway and provides convenient transportation from one side to the other of the river.

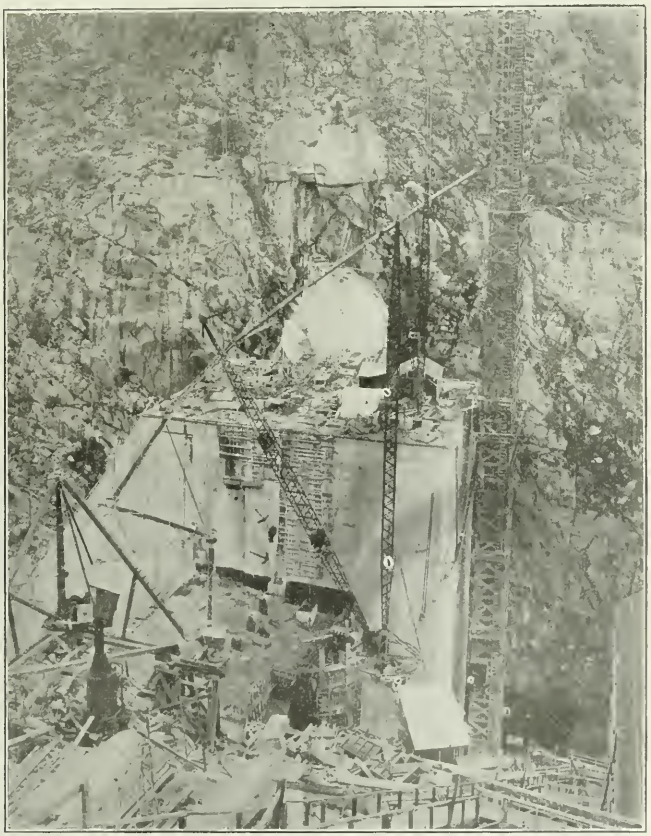
Twelve needle valves, six of them three feet and six five feet in diameter, are used to regulate the discharge of water from the reservoir as desired. The needle valves are backed by hydraulically operated slide gates, and these again by concrete shutters, in order to allow inspection and repair while the reservoir is full.

The irrigationists of Turlock and Modesto have 250,000 acres of farming lands on the lower levels of the Tuolumne River and under the terms of the Hetch Hetchy grant, under which San Francisco is operating, it must allow the natural flow of the water in the stream below the dam up to 2,350 second feet for the irrigationists' use, excess of this being stored for the city's use. Frequently enough floods come down in two weeks, during May and June, to fill the Hetch Hetchy reservoir.

During ordinary levels of the reservoir the water is allowed to flow through the six 5-foot gates, which are placed in batteries of two, at three different levels. Over two years was devoted by the city's engineers to making a study of the best kind of outlet gates to use for this work and, as a result, it was determined to use balanced valves with auxiliary sluice gates and drops to give extra control



CREST AND DOWN-STREAM FACE OF DAM.
City Engineer O'Shaughnessy at the extreme left.



CONSTRUCTION JOINT OF DAM, FROM SOUTH ABUTMENT.
Two arrows in center of picture point to gallery and stairway built in the dam.

during repair. All valves are protected from logs and brush by precast reinforced concrete screen racks, which are built into towers attached to and constituting part of the upstream face of the dam.

An elaborate system of stairways and galleries built in the dam allows complete inspection of the interior of the dam at all times. In order to provide electric current for lights installed in these galleries and for any motors, an electric light and power plant is being installed in the dam.

In preparing the foundation of the dam, large pot holes were disclosed in the bottom of the excavation, which were formed by water action of cascades from ancient glaciers, millions of years ago, which wore circular caverns in the solid granite. It was only necessary to use a sand blast and scrubbing brushes to clean the ancient surfaces to make a desirable contact for new construction.

The name "O'Shaughnessy Dam" has recently been officially given to this structure, because it stands as a monument to the engineering genuis of M. M. O'Shaughnessy, San Francisco's city engineer.

CONSTRUCTION PROCEDURE

The contractors built two camps, one at the bench 400 feet above the floor of the valley, about half a mile above the dam. Rock for the construction was procured from the debris of Falls creek, a mile and a half east of the dam. An excellent bed of sand was found three miles east of the dam.

A railway track was built by the contractors and seven locomotives used for hauling sand and rock materials to the crushers. Stock piles were located here and the materials hauled down to the dam by trains and dumped into separate bunkers, from which it was hoisted by belts up to the mixers, at the base of a tower 350 feet high.

Cement was drawn from a 16,000 barrel storage bunker built on the side of the mountain between the dam and the railway. Cement was hauled to the bunker in bulk in box cars on the railway, thus eliminating waste of time and cement in handling sacks.

This cement was unloaded into the storage bins at the dam site by small slip scrapers pulled by electric motors. The men doing the unloading wore gas masks to prevent the inhaling of dust.

CHRONOLOGY OF THE HETCH HETCHY SUPPLY

1901—Upper Tuolumne River chosen by San Francisco municipal authorities as source of San Francisco's future water supply.

1901—Filings by Mayor Phelan of Tuolumne River and Eleanor Creek.

Jan. 29, 1906—Board of Supervisors voted to abandon the Tuolumne project.

May 11, 1908—Garfield permit issued giving city rights of development of Eleanor or Hetch Hetchy.

Fall, 1908—First bond issue, $600,000, for land and water rights floated.

Jan., 1910—Second bond issue, $45,000,000, carried by vote of 20 to 1.

Feb. 25, 1910—Secretary Ballinger issued order for San Francisco to show cause why the Garfield permit should not be revoked.

July 15, 1912—Report of John R. Freeman filed after two years' study.

Dec., 1913—Baker Bill passed.

Spring, 1914—Road work begun.

July 8, 1914—First contract for construction road to Hetch Hetchy damsite awarded to the Utah Construction Company.

Dec. 6, 1915—Contract for Hetch Hetchy railroad awarded.

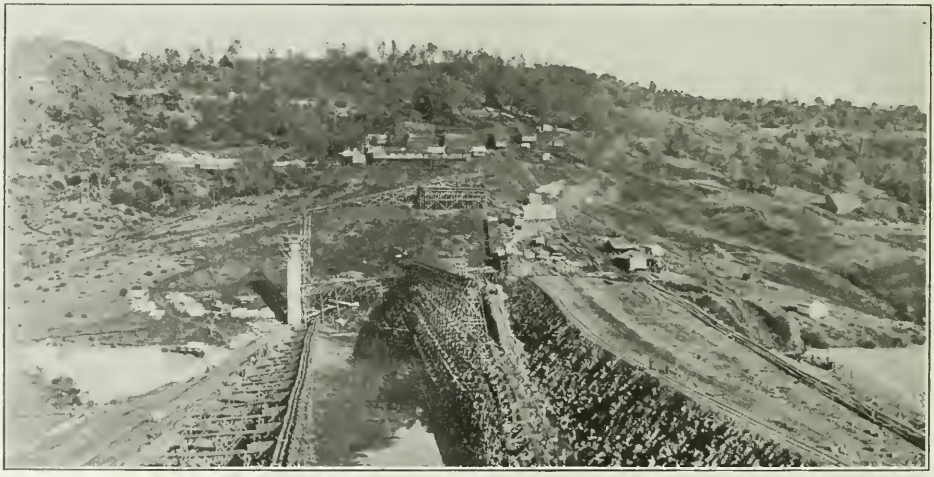
May, 1918—Early intake plant Lower Cherry Power development for construction purposes put into service.

Aug. 1, 1919—Contract for the construction of the Hetch Hetchy dam awarded to the Utah Construction Company.

Aug., 1921—Frames for foundations completed and pouring of concrete commenced.

March 23, 1923—Contract completed, conditional acceptance made.

July 7, 1923—Dedication of O'Shaughnessy dam.



PRIEST DAM UNDER CONSTRUCTION, DECEMBER, 1922.

PRIEST DAM

For several years the water from the dam will be permitted to flow down the natural stream bed a distance of twelve miles to Early Intake, to be there diverted, by means of a small arch dam, into a tunnel about 13 feet in diameter, 18½ miles long, which leads the water to Priest forebay reservoir.

The Priest dam is of the earth fill type and is said to be the third largest dam of that type in the country. Particular interest is attached to its construction owing to the fact that on one side of the core wall long trains of dirt-filled dump cars, operating over a long trestle, unload their contents while water washes the material toward the concrete core wall; the other side is being built up by the hydraulic method, making an impervious puddle core against the upstream side of the concrete core wall.

The concrete core wall extends the entire length of the dam from bed rock to top and is being built in sections, having horizontal joints every 16 feet and vertical joints every 50 feet. All joints are fitted with copper stops to prevent leakage. When completed, the dam will be 1,000 feet long and 145 feet high.

Priest forebay reservoir holds about 2½ days flow of the conduit, and from this reservoir a tunnel 6,000 feet long is built through a spur of the mountain and connected by large pipes to Moccasin Creek power house, which is 300 feet long, built of steel and concrete.

The Moccasin Creek power plant will have a 24-hour average capacity of 52,500 k.w. It is estimated that a revenue of from $1,500,000 to $2,000,000 yearly will be obtained from this power. The revenue will assist the city of San Francisco in financing the remainder of the Hetch Hetchy project, and the energy developed will be a valuable addition to the power resources of California.

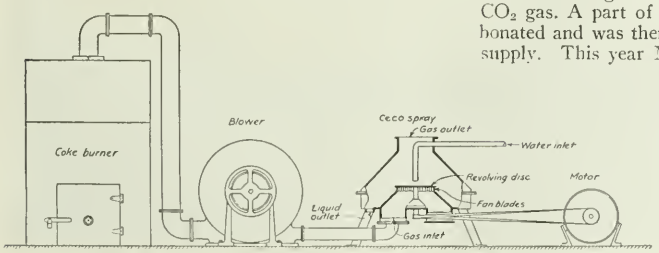
Water Purification in Columbus

The report of the Water Softening and Purification Works of Columbus, Ohio, for the year 1922 contains a description by Charles P. Hoover, the chemist in charge, of some of the studies and experiments made during the year of more than usual interest. One set of studies discloses that temperature is a far greater factor than time in completing the chemical reactions and its effect is more pronounced in water having a hardness of more than 400 parts of 1,000,000 than where the hardness is less than 300 parts. At higher temperature less calcium and magnesium remain in solution than at lower temperatures. At high temperatures the reaction between the lime and the soda ash and the calcium and magnesium salts results in a more crystalline and less soluble precipitate than at low temperatures. As the temperature lowers, more and more soluble and colloidal is the precipitate formed.

Results at Columbus from 12,000 determinations during the past eleven years indicate that the period of reaction between the softening chemicals and the calcium and magnesium salts is short, 90 per cent. of the reaction taking place in the mixing tanks, only 3 per cent. in the fifteen hours while passing through the settling basins, and 7 per cent. while passing through the filters. This indicates that large settling basins are not so necessary for water softening as has always been supposed. Apparently the colloidal precipitates crystallize in passing through the settling basins and are thus removed, but this is not where the chemical reactions take place. Mr. Hoover believes that the filters would have removed the 3 per cent. lost in the settling basins in addition to removing 7 per cent. of the hardness.

At this plant the softening chemicals are added to about 25 per cent. of the water and this overdosed portion is then mixed with the remaining 75 per cent. after which the mixture passes slowly through baffled mixing tanks. The large flocs already formed serve as a nucleus upon which the newly-formed precipitates can build, and as the water rolls over and under the baffles, the floc seems to grow in size and by the time the water reaches the settling basins it is so well coagulated that sedimentation takes place almost instantaneously.

Another line of experiments was in connection with adding CO_2 gas for carbonating the softened water. The first experimental plant consisted of CO_2 gas in cylinders applied to the water by means of a chlorinator. The second plant consisted of a burner for burning coke, and a blower which sucks the gases from the burning coke and forces them into an absorber, where the gas enters at the bottoms and water is fed in at the top. The water drips on to a disc which revolves at the rate of 1800 revolutions per minute and the gas, meeting this film of water, is absorbed by it. The carbonated water discharged from this absorber during a few of the tests contained as high as 600 to 700 parts per 1,000,000 of CO_2 gas. A part of the water was thus highly carbonated and was then mixed with the balance of the supply. This year Mr. Hoover is expecting to test the use of a carbonator used by soft drink bottling plants which produces an effluent showing 24 pounds of CO_2 in 500 gallons. Theoretically a plant which, including a 2-horsepower motor, would cost about $900, should produce enough CO_2 to carbonate 2,000,000 gallons of water.



EXPERIMENTAL CARBONATOR PLANT AT COLUMBUS WATER SOFTENING WORKS.

Recent Legal Decisions

LAND DEDICATED FOR STREET CANNOT BE LEASED FOR PRIVATE USE

The Pennsylvania Supreme Court holds Armsby Land Co. v. City of Pittsburg, 119 Atl. 730, that where land is dedicated for street purposes by the owner and accepted by the municipality, such action is equivalent to a taking, and the property so taken may not lawfully be applied to another and distinct purpose by the municipality unless it be a public use not inconsistent with its use as a highway. It cannot be leased by the city to a corporation or individual engaged in commercial or other pursuits, for private use.

AUTHORITY TO CONSTRUCT SYSTEM OF ROADS NOT AVAILABLE FOR CONSTRUCTION OF PART ONLY

The Indiana Appelate Court holds, Wilson v. Board of Commissioners, 137 N. E. 783, that where a petition for the construction of roads stated that they were so connected as to form one system and prayed that they be voted on as one road, and the taxpayers voted on the system as a whole, the election authorizing the board to construct the system as one road did not give it authority to construct any one or more of the roads less than the whole.

PAVING IMPROVEMENT CONTRACT, DELAYED FOR THREE YEARS WITH CITY'S CONSENT, NOT ABANDONED

The South Dakota Supreme Court holds, Eckhart v. C. H. Atkinson Paving Co., 191 N. W. 441, a suit to restrain the making of a street improvement to be paid for by local assessment, that a contract for a municipal improvement which has been delayed, with the consent of the city, for three years owing to an obstruction of the street, was not abandoned; and the injunction was denied, it not being shown that the work could be done any cheaper now than it could have been done three years ago, or for any less than the amount specified in the contract.

ROAD CONTRACTOR NOT BOUND TO PROCEED WITH CONTRACT WHERE NO STEPS TAKEN TO MEET INSTALLMENTS AS THEY BECOME DUE

When a road district has issued and sold bonds and received the proceeds, and a contract has been let to a road contractor to construct highways in the district, and the contractor has proceeded with the work of construction to the point where all the proceeds of the bonds have been exhausted in payment to him on such contract in monthly installments on estimates of the engineer in charge, as provided by the contract, and the work has not been completed, and the county has taken no steps to issue additional bonds or otherwise provide for meeting the monthly installments as they become due to the contractor, the Mississippi Supreme Court holds, Marshall County v. Callaghan, 94 So. 5, that the contractor is justified in refusing to proceed further with the work.

Where the county sues the road contractor on said contract for damages for a breach thereof in failing to proceed with the construction of the public highways contracted to be built, the county is not entitled to recover unless it alleges and proves that it either had funds in the treasury to meet the contractor's monthly installments, or that it had taken steps by which it would certainly realize such funds.

CONTRACT FOR PLANS AND SPECIFICATIONS OF WATERWORKS CONTINGENT ON STATUTORY REQUIREMENTS

An engineer made a contract with a city agreeing to make the plans and specifications for a waterworks plant and superintend its construction for a percentage of the cost, to be paid from the fund created for the improvement. Although the initial steps were taken by the city council to proceed with the improvement, the assent of property owners necessary under the state statute, was not obtained, and no fund was created. The Circuit Court of Appeals, Eighth Circuit, holds, Cory & Le Cocq v. City of Hankinson, N. D., 284 Fed. 327, that the contract imposed no liability on the city for work done thereunder in making the plans, the plaintiff being aware when the contract was made of the necessity for the owners' consent to the improvement.

TOWN NOT BOUND TO INTERFERE WITH CONTRACTOR TO PROTECT SURETY

The Louisiana Supreme Court holds, Town of Mandeville v. Paquette, 95 So. 391, that the failure of the contractor contracting with a town for the construction of a sea wall to carry storm insurance as agreed did not release the contractor's surety on the contractor's default. The contract contained no provision as to the backfilling keeping pace with the setting of piling and putting on of the coping. It is held that the town owed the surety no duty to interfere and see that the contractor did not leave a long row of pilings unprotected by backfilling and exposed to damage by storms.

BUILDING PERMITS—ORDINANCE AS TO FIRE LIMITS

The city council of Seattle, under section 18 of the city charter, providing that "the city council shall have the power by ordinance to establish fire limits . . . to prohibit the erection within such fire limits of any building . . . and to provide for the removal of any building erected contrary to such prohibition," authorized, by ordinance, the superintendent of buildings to require any building to be removed or demolished when it should be found to be erected in violation of the prescribed fire limits. A building permit was issued, under a mistake of fact, in violation of this ordinance. The Washington Supreme Court holds, Nolan v. Blackwell, 212 Pac. 1048, that the permit conferred no rights to occupancy even though completion of the building was permitted. The ordinance was a sufficient compliance with the charter, and the council was not required to pass a special ordinance to check violations of its general ordinance on the subject.

PUBLIC WORKS.
CITY COUNTY STATE
A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"
Vol. 54 October, 1923 No. 10

Garbage Collection in Saint Paul

By James W. Routh, M. Am. Soc. C. E.*

Lowered cost and improved service secured by substitution of trailers, horse-drawn for collections and tractor-drawn in trains of three to pig farms, for team and wagon collection formerly employed, and still retained temporarily over a large part of the city.

Definite steps have been taken recently towards the solution of the problem of garbage collection in the city of Saint Paul. In an article which appeared in Public Works, March 11, 1922, the then existing procedure in garbage collection was discussed by the writer at some length. Until recently funds have been unavailable for effecting improvements indicated as necessary at that time, but during the last summer it was found possible to appropriate sufficient money for a partial installation of tractors and trailers, details of which are given herein.

GENERAL DATA

At the risk of duplication, certain physical data are reproduced:

The population of the city of Saint Paul is approximately 245,000; the topography is hilly, and the total land area of the city is approximately 52 square miles. There are about 840 miles of streets, of which approximately 25 per cent are paved.

Garbage is disposed of in Saint Paul by feeding it to hogs and by the individual householders burning and burying it. The city does not own a disposal plant, but garbage is fed to pigs by farmers in the immediate vicinity. Some of these men come into the city, operating under license, and collect garbage in selected routes, hauling it to their farms outside of the city limits. There also are three larger piggeries, privately owned and operated, which buy from the city garbage which is collected and delivered to them by collectors employed and paid by the city.

FARMER COLLECTORS

At the date of writing there are thirty farmers operating under license and collecting garbage within the city. These men pay an annual fee of ten dollars each. Nine of them have been assigned routes in the residential sections of the city and are presumed to make two collections each week from them. The remaining 21 farmer collectors take garbage only from hotels, restaurants, clubs, etc. No accurate records are available of the quantity of garbage collected by the latter.

The sections of the city not served by farmer col-

*Consulting Engineer, Saint Paul Bureau of Municipal Research

FIG. 1—TRAIN OF TRACTOR AND THREE TRAILERS HAULING GARBAGE to PIGGERIES.

lectors are covered by collectors employed directly by the city, and working under the supervision of the superintendent of sanitation in the department of public works. During the first seven months of 1923 there were an average of 37 city collectors, who collected and delivered approximately 6,500 tons of garbage to the three piggeries under contract for disposal.

CITY COLLECTORS

During the last two years the public works department has endeavored consistently to replace farmer collectors with collectors who are under the direction of the superintendent of sanitation. This was found necessary because of the difficulty of controlling the individual farmer collectors, who are inclined to display a considerable amount of independence in their choice of equipment and work methods. Some of them have proved satisfactory and regular in their collections, and the better class of collectors, of course, have been retained until the last. The procedure followed is to replace with city collectors the farmers on whose routes complaints multiply.

Until July 1st the city's collectors were paid the rate of $160 per month each. For this sum they provide a driver, who collects, a team and the running gear of a wagon. The wagon boxes are furnished by the city and have a capacity of three cubic yards. They can be emptied only by shoveling and are not water tight; consequently they are unsanitary, even though well cared for and frequently washed.

On July 1st the team rate increased to $168 per month. Under the system of collection by teams the collection cost has been high, approximately $7.00 per ton, the average haul being 4.5 miles.

SALE OF GARBAGE

For the current year, beginning September 1, 1923, the prices per ton paid to the city for garbage delivered to the three piggeries under contract for its disposal are as follows:

District No. 1—$ .90 per ton
District No. 2— 1.07 per ton
District No. 3— .75 per ton

The revenue realized from the sale of garbage is approximately $12,000 per year and is applied to reducing the cost of collection.

TRAILER INSTALLATION

The first installation of trailers and tractors was made following the purchase by the city of twelve side-dump trailers specially designed for use in garbage collection. Figure 1 is a photograph of several of these trailers, which cost $1,595 each. They are drawn by teams for the house to house collections, and are hooked together in trains of three which are drawn from central points to the

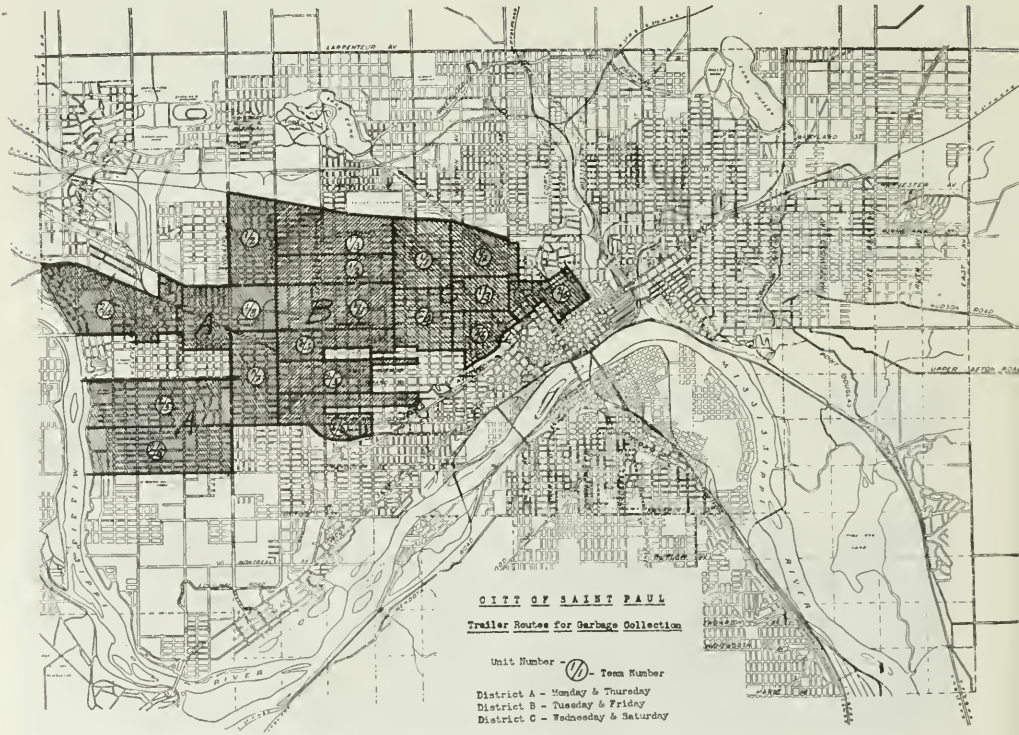

CITY OF SAINT PAUL
Trailer Routes for Garbage Collection
Unit Number - 11 - Team Number
District A - Monday & Thursday
District B - Tuesday & Friday
District C - Wednesday & Saturday

FIG. 2—MAP OF SAINT PAUL, SHOWING THE TRAILER ROUTES AND COLLECTION DISTRICTS. THE DIFFERENT DISTRICTS ARE INDICATED BY THE DIFFERENT SLOPES OF THE CROSS-HATCHING.

piggeries by tractors. Two 5-ton tractors were purchased by the city for this purpose, at a cost of $4,115 each. The trailers are equipped with canvas covers which were purchased separately. The trailers are of special drop-frame construction manufactured by the Highway Trailer Company. They are drawn by 5½-ton G. M. C. tractors.

Figure 2 is a map of the city on which is shown shaded the area served by the tractor-trailer units. The unshaded portions of the city are covered by team collectors, part of whom are employed directly by the city and part of whom, as noted, are farmer collectors operating under license.

The twelve trailers are used in two units of six trailers each. Three teams are employed in each collection unit and are hired at the rate of $8.40 per team per day. The tractors are owned by the city, as stated, and the rate of pay for drivers is $5.08 per day. In addition, there is required a trainman or brakeman for each tractor, who is employed at the rate of $4.40 per day.

COLLECTION PROCEDURE

The area served by the tractor-trailer collectors is divided, as indicated on the map, into three districts. Collections are made in these districts twice a week, the routes for the work being so laid out that each trailer obtains its load in a prescribed time and is then drawn to a central meeting point, where the other two trailers of the unit are joined to it in a train and drawn by the tractor to the disposal point. The tractor, in coming to the meeting point, brings with it three empty trailers which are taken by the teams discharging their loaded trailers and used to collect their next loads.

The installation of the trailers was made under the direction of a representative of the trailer manufacturer, who supervised the laying out of the routes and the instruction of the drivers, and who will return periodically to check up the efficiency of the service and to make such adjustments as seem necessary in order that the work may be carried along properly.

It was noted in the original investigation (made by the writer) of garbage collection in Saint Paul that the collectors worked on an average about 5½ hours a day and actually collected during only 2 or 2½ hours; the remainder of the time was required to haul the loaded wagons to the piggeries. With the trailers a larger load is collected than was possible with the old wooden wagon boxes, and it is possible to collect three loads instead of one each day, the teams and collectors working a full eight hours.

In the district served by the tractor-trailer units there formerly were eighteen collectors. These have been replaced by six teams, two tractors and twelve trailers.

COMPARATIVE COSTS

The tractor-trailer system has been in operation too short a time to permit of accurate cost determinations, but a record system has been installed which enables some approximations to be made. Indications from figures thus far available are that the writer's original estimate—a probable unit cost in the neighborhood of $4.25 per ton—will not be far from the actual cost.

The approximate cost per day of the two units now in operation is as follows:

2 5-ton tractors (operation and depreciation)	@	$12.00	$24.00
2 Tractor drivers	@	5.08	10.16
2 Trainmen	@	4.40	8.80
6 Teams	@	8.40	50.40
12 Trailers—depreciation, etc.	@	1.25	15.00
Total cost per day			$108.36

Each team collects three loads per day, averaging 1.5 tons per load, or a total daily tonnage by the six teams of 27 tons. This gives a cost per ton, exclusive of supervision, of $4.10, as compared with a cost of $7.00 per ton under the former method of collection by teams and wagons. On occasion this figure is improved on, since on days when the garbage is especially heavy as high as 35 tons have been collected at a cost of $3.10 per ton.

CONCLUSION

In addition to the reduced cost, the new collection system accomplishes two highly desirable results:

(a) The territory served actually obtains two collections each week. Formerly the frequency averaged two collections in ten days.

(b) The garbage is collected and hauled through the city streets in water-tight, steel containers, thus alleviating a near nuisance which was unavoidable with the use of the old wooden wagon boxes.

Provision has been made in the city budget for 1924, now before the city council, for funds to purchase additional tractors and trailers to cover the entire city. When this is done licenses to farmer collectors will no longer be granted, and it is hoped that within the next year or two private collection of garbage will be practically discontinued.

There are certain minor problems yet to be considered in making the complete installation, however. One is the question of collections in certain sections of the city where houses are few and widely separated. It has been suggested that such sections can be served by two or more light trucks, which also could be used to make pick-up collections in response to complaints.

Lighting Street for Night Flushing

Street flushing machines in San Francisco intended for flushing at night are provided with a flash or spotlight for illuminating the pavement where the stream is being directed so as to aid the operator in cleaning the pavement more effectively. The light is located just behind the nozzle.

SAN FRANCISCO STREET FLUSHER FOR NIGHT WORK
Arrow points to spotlight used to illuminate pavement and aid operator.

Winter Shipment of Brick

Appearing before the American Construction Council at its meeting on September 21st, the Secretary of the National Paving Brick Manufacturers Association, E. E. Duff, urged that the council encourage shipment of vitrified paving brick during the winter, spring and early summer months and thus avoid the congestion in shipment that annually occurs in September, October and November. Mr. Duff pointed out the physical difficulties encountered by the manufacturer and the monetary loss to the consumer when a big proportion of the shipments had to be made during the fall months when railroad cars are at a premium and transportation systems taxed to capacity. This early shipment could be greatly facilitated if municipalities and highway departments would provide the contractor with a substantial estimate on the material as it is delivered.

Civil Service Examinations

The following examinations are announced by the U. S. Civil Service Commission. Full information and application blanks may be obtained from the Civil Service Commission at Washington, D. C., or the secretary of the Board of U. S. Civil Service Examiners at the postoffice in any city.

Assistant mechanical engineer (internal combustion engines), to fill vacancy in the Bureau of Aeronautics, entrance salary, $6.40 a day. Receipt of applications to close November 6th.

Junior mechanical engineer. To assist in experimental and research tests. Entrance salary, $5.04 a day. Examination to be held on November 7th.

Valuation engineer, to estimate quantity of oil, gas, coal or timber in place,market values, etc. Salaries, $3,600 to $4,800. Also associate valuation engineer; salaries, $3,000 to $3,600. Applications will be received until December 28th.

Junior engineer and deck officer. For vacancy in the Coast and Geodetic Survey. Entrance salary, $2,000 a year. Applications received until December 28th.

NEW YORK STATE CIVIL SERVICE EXAMINATIONS

The director of the Division of Sanitation, Department of Health of New York State, announces that examinations will be held on November 3rd for filling vacancies in two positions as assistant sanitary engineer, one carrying a salary of $3,000 to $3,500 and the other from $2,100 to $2,500. Both positions are open to non-residents. The former requires a knowledge of the design, construction, operation and supervision of water supply systems, water purification works, sewerage and sewage disposal systems; the principles of chemistry and bacteriology as applied to public water supplies, the principles governing stream pollution and its prevention, etc. The second position requires the making of investigations and reports on the construction and operation of water supplies and sewerage systems and water and sewage treatment works, and on stream pollution and sanitary conditions of summer camps and state institutions. The candidates for either position must be graduates of a course in civil or sanitary engineering at a technical school of recognized standing and must have had since graduation experience in engineering, which experience must have been in sanitary engineering extending over four years for the former position, one in the construction or operation of water or sewage treatment works, and have extended over two years for the second position, one of which must have been in sanitary engineering.

Street Cleaning in Newport

The street commissioner of Newport, R. I., John F. Sullivan, states that cleaning streets of that city was changed from the methods of the previous year because of the purchase of an Elgin sweeper. As described in PUBLIC WORKS for January 7, 1922, durable pavements were cleaned in 1921 by the use of 11 men and 3 carts, while 4 foremen, 29 men and 5 carts were employed on macadam streets and others not having durable pavements.

The 11 men and 3 carts were continued until February 21, 1922, and were then replaced by the use of the sweeper together with 4 men and one cart, which are known as a patrol, to clean the permanent pavement streets; the sweeper cleaning the pavements in the early morning while the patrol maintained them for the rest of the day.

"The operation of the Elgin sweeper," says Mr. Sullivan in his report, "also retired one of the season cleaning gangs consisting of one foreman, 6 men and 2 carts. The Bellevue avenue gang was reduced to 2 men and 1 cart, retiring 2 men. This small gang operated on Bellevue avenue from Touro street to Perry street during the summer season only.

"The appropriation for street cleaning was reduced $16,000, from $54,000 to $38,000, consequently it was necessary to make the above changes. The street sweeper has covered many of the asphalt macadam roads formerly swept by these men, making the cost of street sweeping more economical.

"The Elgin sweeper was purchased at a cost of $7,011 F. O. B. Newport, R. I., and has given very satisfactory service. This machine cleans all of the permanent pavements in the early morning and covers many of the asphalt macadam road beds later in the day."

The cost of operating the sweeper for the rest of the year following February 21, comprised $2,488 for labor, $552 for repairs, $357 for gasoline, $197 for oils and grease and $423 for brooms, etc.; giving a total of $4,016 for operating expenses. If we allow 20 per cent. for depreciation and 5 per cent. for interest, we have an added overhead of $1,753, giving a total annual cost of $5,769.

The report shows that the amount of cleaning of permanent pavements done to February 9th was 3,048,390 square yards at a cost of $2,170 or 71 cents per thousand square yards of cleaning.

Following February 9th, the motor sweeper cleaned 12,885,389 square yards, or 879.23 miles of permanent pavements at a cost of $4,016, as

stated above. The patrol covered 16,468,504 square yards during the same period, being to a large extent the same area covered by the motor sweeper, at a cost of $6,225. The Bellevue avenue gang cleaned 2,406,960 square yards at a cost of $1,498; while on all the other streets the cleaning amounted to 7,366,120 square yards and cost $23,920. Reducing these figures to cost per thousand square yards, we find the cost of motor sweeping was 31 cents, by patrol 38 cents, by Bellevue avenue gang 62 cents, and on the other streets without permanent pavements $3.25.

Among numerous other services, the street commissioner cleaned the catch basins connected with the sewerage system using 4 men in the cleaning gang. There were 502 catch basins in the city and these were cleaned 1,114 times, 923 loads of material being removed from them and in the 144 cleanings of "eyes"; the total cost of this cleaning being $5,631. This shows an average of each catch basin cleaned more than twice during the year and about 8/10 of a load of material removed on each cleaning, while the cost per cleaning was apparently somewhat less than $5.00.

Present Status in Refuse Disposal*

Present conditions less satisfactory than before the war. Reduction not remunerative, incineration more expensive. Other methods.

In many places those municipal wastes which are removed in a solid condition have become quite abnormal in character since the war. Not only do ashes contain less coal, but the organic wastes such as garbage contain much less fat and are more than ordinarily variable in quality and quantity.

In America, the reduction process for treating garbage on a commercial scale to obtain the grease has become of little practicability because of the low price and small quantity of grease in comparison with the cost of labor and the needed extractive. Furthermore, the dried solid residue or tankage finds no market, as was formerly the case, as a low-grade fertilizer or filler.

The low temperature incinerators requiring coal or other additional combustible for burning garbage are interfered with by the scarcity as well as the high price of coal.

The few high-temperature destructors in America are handicapped in varying degrees at different times and places by the comparative absence of combustibles.

More garbage than ever before is now sent with other refuse to the dumps and indifferently burned when weather permits. Considerable garbage is ploughed into the fields. Many sizable cities during and since the war have tried the plan of feeding garbage to pigs. But this arrangement in connection with short-term contracts has not proved nearly as satisfactory as in the New England states, where hog farms have been gradually developed through a term of years on a sizable scale to meet the needs of growing cities. Dissatisfaction has come in part from the low price of pork and partly from the complaints arising from objectionable conditions in the opinion of those living in the neighborhood of the hog farms.

New York City is barging its garbage to sea. This is not wholly satisfactory, as the harbor is somewhat littered at times by stray portions of garbage detached from the barges. Odors are complained of both from moving barges and those tied to the docks, especially when held there awaiting suitable weather for towing to the open sea. Furthermore, the wind and tides move some of the garbage to the bathing beaches along the neighboring coast.

Taking everything into account, it is fair to say that at present there is no problem in sanitary engineering in America that is being handled with less satisfaction to the citizens than that of garbage disposal.

At Frankfort, I found that the destructor plant has been out of service for three years, and the garbage is being ploughed into the ground. At Zurich this step is being considered, although the destructor is still in operation. The sale of electric current by the plant has dropped due to quality of the refuse and the increased cost of labor to twenty-two francs per eight hours has resulted in a deficit of about 125,000 francs per year instead of a surplus of 25,000 francs. This deficit is barely met from the surplus from the refuse collection department, for which there is a special tax of half a franc per room per month.

In other continental cities destructors have not been operating normally for some time. In Italy there are six or eight cities where the Beccari system is in use. It consists essentially in placing the garbage, after sorting, together with the street sweepings, into a closed concrete chamber, the single compartments of which have a capacity of about twenty-five cubic yards. At the end of thirty-five to forty-five days the organic wastes have become fermented so that they resemble humus which after screening is said to make an excellent fertilizer, selling for forty to fifty lira per one hundred kilos.

I visited the plant of this type at Florence which has been in operation for several years, serving about one-half of the city. It receives street sweepings, as well as garbage, and also some farmyard manure. There were very few flies except where the surplus refuse was stored in piles awaiting treatment in the overtaxed plant. Odors were practically absent except in a shed where they stored old bones removed from the garbage. The fermented product had no objectionable odor, and after screening resembled humus. On the screens were particles of unfermentable rubbish and resistant organic matter which it was said should be put into a cell again.

It was my understanding from the technical descriptions of this process that the fermentation was conducted on an oxydizing basis with air entering the

*Part of a paper on "Recent Developments in Sanitary Engineering," read by George W. Fuller before the Institute of Sanitary Engineers, England, on September 10th.

entire mass during the thirty-five to forty-five days during which the temperature rises to 140 to 180 degrees Fahr. But from my observations I should doubt whether the air penetrates the mass of garbage so as to maintain an aerobic fermentation. It seemed to be an anærobic or septic decomposition, with the air inlets in each corner of the cell simply serving to promote the removal of gas through a vent in the roofs of the cell, and on which is a tower with trays filled with soil and iron sulphate.

The Florence plant seems to furnish promising results, although lack of funds prevents it being doubled in size and provided with labor-saving mechanical equipment. I understand that a test plant has been erected at Paterson, N. J., about twenty miles west of New York. I am not informed as to results there obtained, but it seems to me that the first thing to do is to determine definitely whether the main body of material is fermented with the bacteria and other organisms working in the presence or absence of atmospheric oxygen. This seems essential to the suitable control of operations.

Dayton's Waste Paper Receptacles

Street receptacles for waste paper are being installed in the downtown districts of Dayton, Ohio, which promise to be successful financially as well as from the standpoint of service, the sides of the cabinet being utilized for displaying advertising matter under a franchise granted to two citizens of Dayton by the City Commission in December, 1922.

DAYTON'S NEW TRASH RECEPTACLE.

The ordinance provides that the cabinets shall be installed, and maintained clean and in repair for two years from February 1, 1923, at places designated by the city, the city to receive the sum of $50 per year for each cabinet installed. The owners derive their revenue from the sale of advertising space on the sides. The city reserves the right to control the character of the advertising, no political, theatrical, immoral or otherwise objectionable displays being permitted. During the period mentioned the city can purchase the cabinets at a price of $300 each less 10% for depreciation. Thus far no adverse comments or criticisms have been received and the only trouble found is that the cabinets are sometimes mistaken for mail boxes, $6,000 worth of bonds having been deposited in one of them by mistake.

They are installed and maintained under the supervision of the Department of Public Service, of which George F. Baker is director. The city empties the contents into wagons and removes it as it has always done with similar receptacles. They are generally emptied three times a week, early in the morning on Tuesday, Thursday and Saturday. The cost of collection is considerably less than the revenue received.

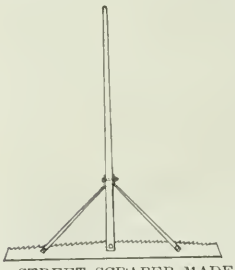
The cabinet is triangular in shape, about 30 inches on each side and 5 feet 6 inches high. It is of metal with embossed trimmings at the edges and between the advertising spaces, weighs about 300 pounds and is waterproof throughout. The base is of cast iron and the sides of bronze alloy. One space on each side is used for a city slogan, "Keep Dayton Clean." The other spaces, with the exception of those used for openings for receiving waste, are used for advertising, the placards being held in place by heavy glass plates. The rubbish receptacle, a triangular shaped metal can, is placed in the lower part and is removed for emptying through hinged doors which are locked when not in use. The upper part of the cabinet, also reached through locked doors, contains a police telephone and emergency kit. Red lamps, which can be used as a police signal system, are mounted on top of the cabinets, and two 40-watt 115-volt lamps with tube-like bulbs about 14 inches long are placed under the eaves on each side so as to illuminate the advertising.

Fifty of these cabinets have been arranged for by the city and at the time of our advice about a dozen had been installed.

Street Scrapers from Old Saws

At least three of the cities sending us street cleaning information use old saws in making scrapers for cleaning pavements. L. O. Parks, Superintendent of Streets of Talladega, Ala., one of the cities referred to, sends us a description and sketch of the way the scrapers are made in that city.

Discarded cross-cut saws are obtained for practically nothing and a local blacksmith furnishes and attaches handle and braces for $1.00, the handle being made from an old buggy shaft or some similar piece of wood. The back of the saw is used for the scraping edge. The ends are cut off at an angle so that the scraper can clean along the base of the curb.



STREET SCRAPER MADE OF OLD CROSS-CUT SAW.

The length of saw used is 6 ft.; the

handle is 6 ft. 6 in. long, and the braces are 2 ft. 6 in. long, of ⅞-in. flat iron. A slot is sawed into the larger end of the handle to receive the saw, and a hole is drilled through handle and saw to receive a bolt or rivet. One end of each brace is riveted to the saw, and through the other ends, bent up along the handle, as shown, another bolt is passed.

Mr. Parks says that the scraper serves the purpose well and is not inconveniently heavy.

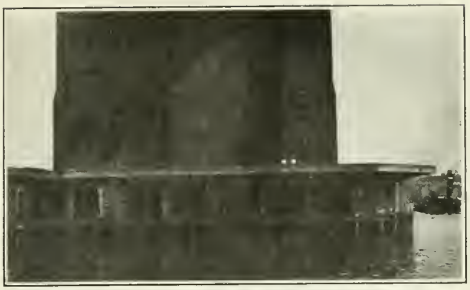
New York's Concrete Municipal Dump

By Frank W. Skinner

City will use, for dumping refuse onto scows, an elevated platform enclosing base of Brooklyn bridge tower, which affords 630 lineal feet of cantilevered dumping floor with easy approach and exit ramps.

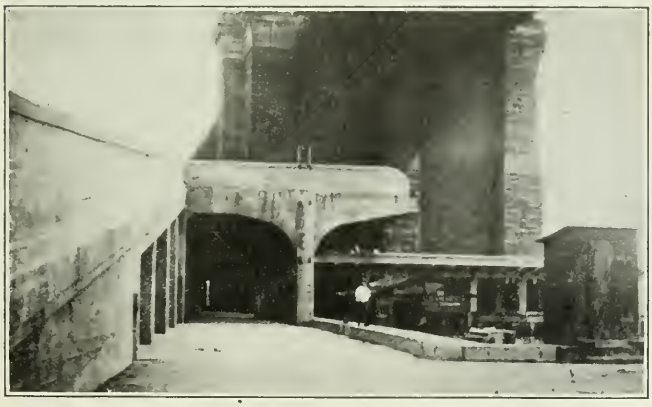
The concrete pier in the East River, at the foot of Roosevelt street, New York, is built entirely around the west tower of the Brooklyn Bridge and is connected to the shore by a section about 90 feet wide and 300 feet long, approximately perpendicular to the bulkhead line. It has a heavy reinforced concrete deck, carried on 933 16x16-inch piles, 46 to 80 feet long, which were pre-cast at the contractor's yard at Hunts Point, and driven by successively jetting with two 3-inch nozzles and setting to accurate position with a steam hammer at a maximum rate of twenty-five piles per day, as described in Public Works for December, 1922. The pier cost about $500,000 and was built by the George B. Spearin Company of New York City, which subsequently received the contract for constructing on it the dumping platform described in this article.

The dumping platform is intended to deliver excavated material, garbage and other refuse directly from trucks into dump scows moored to the substructure of the pier below the overhang in such a position that six scows can be loaded simultaneously by gravity without requiring any trimming or shifting of their loads, thus securing minimum expense and maximum rapidity of operation with very few attendants. It was designed for the Department of Docks by Major Henry Asserson, who adapted features of similar docks in Havana that had attracted the attention of former Commissioner of Docks Murray Hulburt.



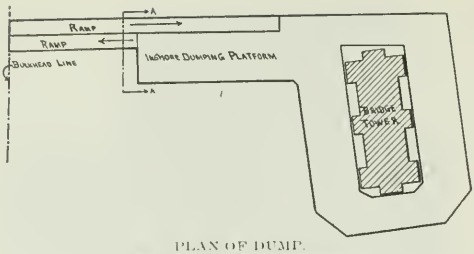
DUMPING PLATFORM ON RIVER SIDE OF TOWER.

The rectangular main portion of the dumping platform has a 150x225-foot horizontal floor completely enclosing the 59x140-foot bridge tower with a minimum clearance of 15 inches from it. This affords clear widths of 36 feet, 30 feet, 48 feet and 48 feet on the south, north, east and west side of the tower, respectively, the northwest corner of the platform being provided with a 64-foot wide extension, affording 150 lineal feet additional dumping space and connected with the ramp leading to the bulkhead line at South street. The total distance from the foot of the ramps to the river side of the dumping platform is about 430 feet. The main platform is horizontal, except that it pitches 3 inches from each side of the tower to the dumping edge, and is 27 feet above mean low-water. The incoming ramp, 275 feet long and 15 feet wide, has a grade of 2.8%, making it easy for the loaded trucks, while the outgoing ramp, 125 feet long and 15 feet wide, which is separated from it by a solid web concrete fence 5 feet high with panels 20 feet long and 6 inches in minimum thickness, has a steeper grade of 6.2% for the empty trucks.

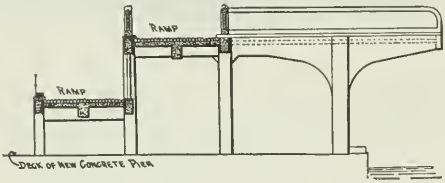


INSHORE DUMPING PLATFORM AND DESCENDING RAMP.

The floor slabs, 7 inches thick, proportioned for a maximum load of 500 pounds per square foot, are carried on longitudinal beams 6 or 7 feet apart and transverse girders, generally about 20 feet apart, that are supported on vertical columns from the deck of the main pier. The dumping platform has a total length of 631 feet, cantilevered 16 feet beyond the centers of the outside columns, and



PLAN OF DUMP.

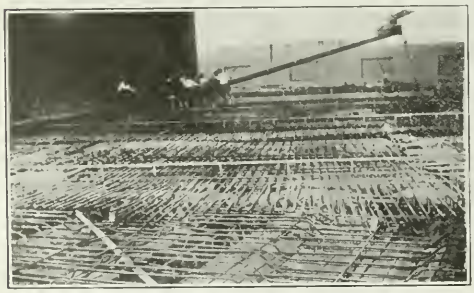


SECTION OF RAMPS AND PLATFORM AT A A.

terminates in a concrete curb and a 12x12-inch backing log securely bolted to it.

The cantilever girders supporting the overhang have solid-web knee-braces integral with the columns. All of the columns have rectangular cross-sections from 18 to 30 inches square with reinforcement varying from four ⅞-inch round bars to thirty-two 1-inch square bars. The inner side of the platform is protected by a pipe railing and is lighted by electric lamps on poles about 15 feet high. Ramps and platform are paved with granite blocks 5 inches thick laid on a 1-inch dry mortar bed.

The concrete was all mixed and placed by a floating plant installed on a 90x34-foot scow 8 feet deep, which was moored alongside and moved from place to place to command the entire area. The scow was equipped with a 1-yard Ransome mixer, a chain-belt conveyor delivering cement to the mixing platform and a 74-foot derrick boom supplying aggregate to the two 12-yard elevated storage bins. The concrete was hoisted in a 50-foot tower and spouted to a maximum distance of 66 feet by steel chutes carried by the tower boom. The concrete plant was operated by a force of about twenty-five men and had a maximum output of 300 yards in eight hours. The 2,800 yards of aggregate required were delivered by 500 to 700-yard barges that were moored alongside the mixer scow and unloaded by its derrick boom equipped with a clamshell bucket that filled the elevated storage bins.



CONCRETING FLOOR SLAB FROM FLOATING PLANT.

The principal quantities involved were 2,500 yards of concrete, 260 tons of corrugated bar reinforcement from ⅜ to 1⅛-inch square, and about 200,000 feet, board measure, of lumber for the 110,000 square feet of form surface, about three-fourths of the forms being erected at one time. Operations were commenced April 1st and finished about August 1st with a maximum force of 100 men under the direction of R. D. Love, superintendent for the contractor.

Refuse Reclamation at Halifax

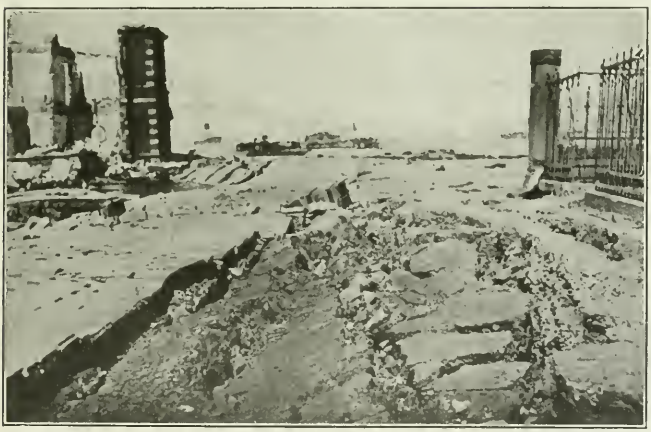
Fertilizer and gas to be manufactured and the latter used for creating power.

The town of Halifax proposes to reclaim all its refuse and has applied to the Ministry of Health for permission to borrow 15,111 pounds for constructing a plant. At present the refuse, amounting to about 22,000 tons annually, is placed on dumps. From information furnished by W. H. Sagar, the cleansing superintendent, to "Municipal Engineering" of London, we obtain the following information concerning the plant:

Halifax has a population of just over 100,000. The city is by no means thoroughly sewered, as there are still 16,000 pail closets in use, and it is proposed to utilize the contents in producing fertilizer in connection with screenings from the refuse.

There will be a screen 18 feet long by 5 feet in diameter, the first 12 feet containing ¼-inch or 5/16-inch wire mesh and the remaining 6 feet, 1½-inch mesh. To allow for a variation of moisture in the refuse, so that damp material can be given a longer screening than that which is dry, the screen is designed with a tilting arrangement allowing it to assume any angle with the horizontal up to 12 degrees, the angle being variable while the screen is in motion. The dust coming through the fine mesh will fall into a small hopper and will be carried about 100 feet by means of a pneumatic suction plant operated by a 15-horsepower motor which will draw the dust through a 4-inch pipe and deposit it in a hopper immediately over a pug mill in which it will be mixed with the contents of the pail closets. The pail material will be deposited in a sealed concrete tank, from which it will be drawn by a centrifugal pump and lifted into the pug mill where it will be mixed with the dust from the screen. This pug mill is a U-shape trough about 6 feet long with two parallel shafts, each carrying small knives which revolve in opposite directions. The mixture falls on to a belt conveyor by which it is carried direct to a railway car for transportation.

Probably the most novel feature of the proposed plant is the vegablegas producer by which it is proposed to make gas from the refuse. Mr. Sagar says that if the working plant produces 75% the efficiency of the test plant, it will be successful. From tests made by charging the producer with a light combustible matter such as paper, rags, carpet, oilcloth, banana stalks, straw and general market refuse, 47,000 cubic feet of gas was produced per ton of refuse with an average calorific value of 130 b.t.u. per cubic foot. After passing the gas through a cascade scrubber, extracting the tar, and then through a dry scrubber in a manner similar to that employed for coal gas, the gas is passed to a double mixing box in front of a boiler which stands on three castiron cradles and requires no brickwork. The boiler is 21 feet long by 5 feet 6 inches diameter and contains 172 tubes which run the full length of the boiler and give a heating surface of 1,500 square feet. Opposite each tube and about 3 or 4 inches from it is a burner, from which the flame passes into the tube and is drawn through it by an induction fan placed at the chimney end of the boiler. The combustion is so complete that only a 30-foot steel chimney 10 inches in diameter is required to carry away the fumes. The evaporation test has shown 3 pounds of water per pound of fuel from and at 212 degrees. The boiler is capable of producing 8,250 pounds of steam per hour. The steam will be used to drive a 225-horsepower vertical compound engine with a direct coupled alternator, which will produce power for driving the salvage plant and the fish plant, with a surplus for lighting the premises and other purposes. The residue from the consumption of the refuse will consist of a white ash containing a good percentage of potash which will be mixed with the dust for enriching the fertilizer.



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EFFECT OF EARTHQUAKE IN JAPAN.

The above photograph was taken in the Customs Compound at Yokohama, looking toward the harbor. The block pavement on the left shows pronounced waves in longitudinal profile; while that on the right, which looks like bituminous concrete, has apparently settled into a crevasse or furrow.

Lynchburg's Public Works Report

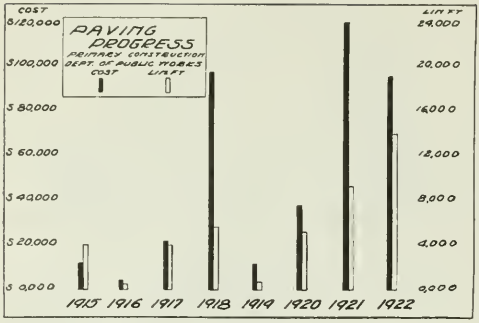
O'd brick pavement relaid with asphalt filler. Economy in improved maintenance methods. New appliances for cleaning and sprinkling streets and removing snow.

The annual report of the city of Lynchburg, Va., for the year ending January 31, 1923, is a most creditable pamphlet in attractiveness of appearance, in manner of presenting the facts and in the facts themselves. The ninety-three pages of heavy coated paper, inside a most artistic cover, contain 23 reproductions of photographs and 11 diagrams, which must greatly aid in giving the taxpayers a clear understanding of the most important statistics of the city's functioning.

The message of Mayor Fred Harper pays a high tribute to the city manager, E. A. Beck, who has charge of practically all the municipal operations except those connected with the schools, finances and law. The expenditures totaled $620,124 for general operation and $227,208 for capital outlay; the total disbursements being $1,778,407. Some of the more interesting items of the report of the Department of Public Works are given below.

A distance of 1,055 feet of Madison street was repaved by city forces. The old pavement was brick 46 feet wide laid in 1892. The bricks were taken up, cleaned, sorted, and relaid. The pavement was narrowed to 27 feet, leaving 9½ feet on each side for a parkway. As the area of the new pavement was but 60 per cent. that of the old, sufficient old brick were available to repave and also to lay a block of roadway elsewhere. The brick were laid with asphalt filler on a concrete base. The entire cost, including additions to storm and sanitary sewer systems, was $10,835.

The paving of four miles of dirt streets, together with economies resulting from improvements in methods of maintenance, substantially decreased the cost of upkeep of unpaved streets, or from $18,058 the year before to $11,846 in 1922. The work done on unpaved streets comprised dragging 2,643 blocks, grading and shaping 246 blocks, cinder surface on 148 blocks, and constructing 44



ONE OF THE CHARTS IN LYNCHBURG'S REPORT.

inlets and 5 pipe drains. Of the total cost, $11,846, $1,054 was for material and the rest for labor. In addition there should be charged against this work $4,318 for teams and trucks furnished by the city garages and stables.

The paved streets are of slag macadam, asphalt macadam, brick, concrete, rubble and cobble. Of the first, 30,440 square yards were laid last year at a cost of $14,766, or 48.5 cents per square yard. Of the total area of 216,200 square yards of asphalt macadam, 66,282 square yards was reconstructed or resurfaced at a cost of 20 cents per square yard.

The Bureau of Street Cleaning swept 2,006 blocks in the business district at night, removing 300 loads of sweepings at an average cost of $1.62 per block, while hand sweeping during the day on the same area cost $2,248. Mechanical sweeping of the residential and semi-business sections cost $9,797, 9,756 blocks being swept and 2,577 loads of sweepings removed. These costs include "value of time of teams and trucks furnished by city stables and garage," totaling $5,273.

In June, the department assembled a motor driven combined sprinkling and sweeping unit by adding sprinkler equipment to a sweeper and attaching a Fordson tractor to it. This replaced an outfit consisting of an independent sprinkler and sweeper, each drawn by 3 horses, and reduced the average cost of mechanical sweeping 35c per block.

During one storm at the close of January 1922, snow fell to a depth of 20.3", the greatest within the 30 years during which official weather records have been maintained. Although all traffic lines within the city were cleared within 36 hours, this experience impressed the need of mechanical equipment for such an emergency. The department shops therefore designed and constructed a snow plow for operation in front of a 3½-ton motor truck. During later snows this equipment cleared the streets (both sides) at the rate of a mile an hour.

REPAVING BRICK STREET BY CITY FORCES IN 1922.

Garbage Disposal in Kansas

Data concerning fuel disposal have been obtained from Kansas cities of the first and second class and compiled by Harvey Walker, assistant secretary of the League of Kansas Municipalities, and this information was published recently in the organ of that League. From this we abstract the following information concerning the disposition made of garbage by these cities.

Inquiries were sent to 87 cities of the first and second class in the state of Kansas. Eleven failed to report or gave no definite information on the subject, while 39 reported that they had no system of garbage disposal. Of the remaining 37, 28 disposed of garbage by feeding it to hogs. In all but one or possibly two cases the hogs were privately owned, and in the majority of cases the garbage was collected by the hog owners, although in a few of the cities it was collected either by city employees or by parties under contract with the city.

Of the remaining 9 cities, 4 hauled the garbage to dumps, 2 burned it, and 3 buried it, 2 of the last reporting burning that which was readily combustible. Apparently none of the burning was done in incinerators but only in the open.

Paving in New York State

The amount of paving done by the New York State Highway Commission will probably exceed 3,000,000 square yards this season. At the height of the season approximately 1,000,000 square yards per month were being laid under more than 200 contracts on which nearly 7,000 men were employed. The maintenance force employed by the state numbered over 4,800.

Longest Straight Street in the World

Philadelphia claims to have the longest paved street in a continuous tangent to be found in the world. This is Broad street, which is 13.8 miles long and varies in width from 113 to 300 feet, all of which has been paved except one small strip and paving on this probably will not be delayed much longer.

Highway Revenues in Kentucky

The secretary of the State Tax Commission of Kentucky reports that during the fiscal year recently ended the revenue from the 1 cent gasoline tax totaled $586,188.50, which was an increase of approximately 25 per cent over that of the previous year. The revenue from this tax accrues to the state road fund.

Refuse Disposal in Chicago

Improvement and extension of reduction plant. Amount and cost of collection of ashes and rubbish and of street cleaning and snow removal.

The latest annual report of Thomas H. Byrne, superintendent of streets of Chicago, shows that during the year covered by the report the city collected 107,292 tons of garbage at a cost of $503,932 for collecting and hauling, $20,524 for handling at loading stations and $73,404 for boat hire; a total of $597,860, or $5.57 a ton, or 21c per capita. This material was delivered to the reduction plant, some by boat from loading stations and some by direct haul.

Due to the installation of a new dryer equipment, garbage grease was not produced during the first five months of the year and very little tankage was manufactured; 1,143 cars, containing 40,660 tons of dry garbage and refuse, being shipped from the municipal reduction plant to Hawthorne for disposal. During the remaining seven months the plant produced 3,118,640 pounds of garbage grease, or 2.2% of the weight of garbage, and 7,192 tons of tankage, or 8% of the weight of garbage.

Eugene Vollmar, foreman of the Bureau of Waste Disposal, reported that the reconstruction of the plant has placed it in a first-class operating condition to manufacture garbage grease and garbage tankage, placing in operation three revolving percolators in the new extraction plant and four Page-Burton boilers in the new boiler house, which equipment was installed five years ago. In addition, the plant now has six new direct heat primary dryers and furnaces, two new indirect heat finishing dryers with new transmission, five new percolators in the old extraction plant, two new pulverizers in the receiving building, six exhaust fans in the No. 1 dryer building, a 20-ton locomotive crane, a 20-ton truck scale, two steel breechings, together with new conveyors and other machinery.

The net cost of operation, including repairs and removal of rubbish, was $530,857, or $5.10 per ton. This was obtained by deducting from the total operating expenses the total revenue obtained by the sale of by-products, the latter corrected by a comparison of the inventories at the beginning and end of the year. However, considering only the last seven months, after the improved plant was in operation, the operating cost was $5.93 per ton, revenue $1.79, and net cost $4.14. Garbage grease was sold at 3.3c per pound, animal grease at 5c per pound, calfskins at 9.42c per pound, tankage at $4.95 per ton, rags at $3.89 per ton, bones at $20 per ton, scrap iron at $4.32 per ton and other trade wastes at $10 per ton. The operating expenses consisted of $382,403 for salaries and wages, $66,342 for fuel oil, $14,012 for power, $1,565 for light, $66,204 for coal, $93,515 for supplies and repairs and $36,327 for removal of dried garbage and rubbish. An average of 230 men were employed at the plant throughout the year, a number which "made it possible to dispose of the garbage without overtime and to close the plant one day per week in addition to Sundays and holidays for about thirty weeks when the receipts were insufficient for full-time operation."

The amount of raw garbage received varied from a minimum of 5,569 tons during February to a maximum of 12,660 tons during September. The total amount for the year was 3.31% greater than during the preceding year.

The Bureau of Streets collected and hauled to the city dumps 2,011,948 cubic yards of ashes and miscelloneous waste, of which 232,879 cubic yards was collected and hauled by auto trucks. Also 17,043 cubic yards was spread by hand in alleys that were below grade. The cost of collecting and hauling was $2,236,239 and the cost of maintaining the city dumps was $101,566. The total give a cost per cubic yard of $1.16, or 81¾c per capita.

The area of streets cleaned, using the block and gang system, totalled 2,815,393,914 square yards. From this area 338,615 cubic yards of dirt was collected, of which 3,598 cubic yards was dumped on low ground. This work cost, for labor and teams, $1,775,132, for material and supplies $23,298, and $3,407 for hauling street dirt in railroad cars. This gives a total of 64c per thousand square yards cleaned, or 63c per capita.

In addition, 91,826,463 square yards of alleys were swept and cleaned at a cost of $58,779 and 4,311,788 square yards of weeds were cut at a cost of $7,077. Auto flushers in the First Ward flushed and cleaned 100,291,686 square yards of streets, using 22,005,300 gallons of water, the cost of this being $7,302 for drivers, helpers and labor and $1,958 for gas, oil and repairs, an average of 9c per thousand square yards. Horse-drawn flushers in the First Ward cleaned 14,443,139 square yards, using 4,868,000 gallons of water, the cost being $6,532. Auto flushers working in all the other wards cleaned 261,270,987 square yards of streets, using 68,653,200 gallons of water, the cost being $19,123 for drivers and helpers and $4,391 for gas, oil and repairs, giving an average of 9c per thousand square yards. Auto sweepers cleaned 37,923,732 square yards of streets at a cost of $4,901 for drivers and helpers and $2,498 for gas, oil and repairs, an average of 19½c per thousand square yards.

Snow removal in the First Ward cost $11,747, 5,104 cubic yards being removed from 5,315,676 square yards of streets. In all the other wards 2,479 cubic yards of snow was removed from 1,863,112 square yards of streets at a cost of $5,371.

Flood Protection in San Antonio

Preliminary data are being collected and plans prepared for the construction of flood protection works for a portion of San Antonio, Texas, preliminary

estimates indicating a cost of about $5,500,000. The flood prevention work contemplated consists of a concrete retention dam approximately 2,200 feet long to cost about 2¼ million dollars; the widening and straightening of the channel of the San Antonio river and its tributaries, to cost approximately 1¼ million dollars; and the reconstruction of bridges and other public improvements made necessary by the channel changes, which will cost approximately 1½ million dollars.

In addition to this, the city proposes to spend about 2 million dollars for paving, sewers and parks. D. D. Harrigan, city engineer of San Antonio, has been in charge of all of the investigations and surveys made in connection with this work.

Referendum in Reforestration

The Chamber of Commerce of the United States is taking a referendum of the more than 1,200 organizations in its membership on the subject of national forestry, eight points being submitted for expression of opinion. These are in the form of recommendations calling for Federal and state action as follows:

That the Federal Government acquire, re-seed and replant waste lands where forests will not grow by natural means and to the extent permitted by law; that states and municipalities take similar action on land where the Federal Government cannot act; that Congress provide for similar treatment of other classes of timber-land by cooperation of the Federal and State Governments and timber owners in protection and reproduction of timber; that Federal funds be contributed only to states that have a forestry or conservation commission, that formulate a code of forest management, maintain adequate protection of the timber-lands from fire (funds from state and private sources to at least equal the Federal appropriation), and that base taxation of growing timber on the principle of the yield tax; that Congress create a national forest council containing representatives of the public, timber men and foresters; that Congress provide for a national survey and inventory of forest resources; that it increase the Federal appropriations available for protection of timber-land against fire; and that it provide for enlargement of Federal research and experiment in forest products. Two members of the Chamber of Commerce Committee that formulated the referendum disapproved of the recommendation for the creation of a national forest council.

New England Waterworks Convention

The Forty-second annual convention of the New England Waterworks Association was held in Burlington, Vermont, September 18th to 21st, at the Hotel Van Ness. The exhibits were on the ground floor adjacent to the secretary's office while the meetings were held on the floor above. The attendance by Wednesday night included 130 active members, 86 associates and 175 guests. In spite of the counter attractions of golf and the beautiful country in and around Burlington, the seating capacity of the hall which was 88, was on a few occasions exceeded by the attendance, while it was perhaps two-thirds filled during most of the sessions.

The morning, afternoon and evening sessions of Wednesday, Thursday evening and Friday morning were occupied with the reading and discussion of papers; on Tuesday afternoon occurred the opening addresses and the reading of one paper. The diversions consisted of a trip to Fort Ethan Allen on Tuesday afternoon and a reception and dance that evening; an all-day excursion to Ausable Chasm on Thursday, and golf throughout the week. Teas, whist parties, an automobile trip, etc., were provided for the ladies. The weather was excellent throughout the convention except for light rain on Friday which inconvenienced only the golfers.

The report of Secretary Gifford showed a net loss of 59 in the membership during the eight months from January 1st to September 1st, the association year having been changed from the former to the latter date in accordance with recent changes in the constitution. The membership September 1st was 769, which was 274 less than it had been six years previous. Some of this year's loss was due to the dropping of members for non-payment of dues, and it is hoped that some of these will be restored to membership.

In spite of the decrease in membership, the finances of the society are in good condition, the report of Treasurer Winslow showing a considerable balance in both ready cash and invested funds. The net cost of publishing the journal was $341 and the amount paid for rental of the society quarters in Tremont Temple and the assistant secretary was $1,983. For some years previous these last two items had cost $1,950, before the society became one of the affiliated technical societies of Boston. President Sanders, in his address, referred to this fact, stating that since the affiliation the assistant secretary has been the clerk of the affiliated technical societies and has been paid by the organization, while the association pays to the organization $3 per member, adjusted for duplicate membership.

The teller of elections, Henry T. Gidley, announced that 249 votes had been cast, David A Heffernan, superintendent of waterworks of Milton, Mass., receiving 246 votes for president; Theodore L. Bristol, of Ansonia, Conn., 244 for vice president and Stephen H. Taylor of New Bedford, Mass., 242 for vice president, Mr. Bristol to serve two years, and Mr. Taylor, one year; for directors to serve two years, George A. Carpenter, of Pawtucket,

R. I., received 242 votes and Arthur E. Blackmer, of Plymouth, mass., 232 votes, while for a one-year term, George W. Batchelder, of Worcester, Mass., received 244 votes, and Frank Emerson, of Peabody, Mass., 227 votes. Frederic I. Winslow was reelected treasurer. All of these were the nominees whose names appeared on the official ballot.

Honorary membership in the association was conferred upon John R. Freeman, the presentation being made by Charles W. Sherman and accepted by Caleb M. Saville as representing Mr. Freeman who was unavoidably absent. Following this, the Dexter Brackett Medal for 1922 was conferred upon Charles W. Sherman for his paper entitled, "Bond Issues—Over What Period Should They Run?" the medal being presented by Frank A. Barbour.

TUESDAY'S SESSION

The convention opened on Tuesday afternoon with a welcome to the association by J. Holmes Jackson, mayor of Burlington, and C. S. Ordway, president of the Burlington Chamber of Commerce, reply being made by President Sanders. The opening session concluded with a paper by Oliver J. Channing, pumping engineer of Burlington, describing the filtration of Burlington's water. The paper dealt more with the results than the method. Mr. Channing stated that during the period 1904 to 1908 there were 151 cases of typhoid, although the intake was two miles out from the shore in Lake Champlain. Mechanical filters were introduced in 1908 and in the two years 1909 and 1910 there were 29 cases of typhoid. In December, 1910, the city began using hypochlorite and in 1911 there were only 7 cases of typhoid, 6 of these being traced to out-of-town sources. Liquid chlorine was substituted for hypochlorite in 1921, and in 1922 there was but one case of typhoid in the city. Some discussion followed. G. H. Pratt, of Wallace & Tiernan, stated that chlorination generally cost about 50 to 60c per million gallons, while the least expensive installation cost about $600 and the largest units up to $1,500 or $1,600 each.

WEDNESDAY'S SESSIONS

Wednesday morning's session opened promptly (as, in fact, did all of the sessions of the convention) with a paper by Charles P. Moat, chemist of the Vermont State Board of Health, who described the "Public Water Supplies of Vermont." A supply is considered public in that state if there are 10 or more consumers. There are 106 such supplies in the state and about 50 vacation camps. Mr. Moat described the outstanding features of many of the supplies, especially as to their quality. Most of them are from surface sources and most of these should be chlorinated but only a few are. Vergennes uses a badly polluted supply and suffers considerable typhoid in consequence but has so far refused to adopt any precautions urged by the State Board. One interesting statement of Mr. Moat's paper was that B. coli had been traced conclusively to deer droppings on the watershed of one of the supplies.

A paper written by Edwin H. Rogers, city engineer of Newton, Mass., entitled "Sub-surface Collecting System and Quality of Water of Newton, Mass.," was read by the secretary in the absence of Mr. Rogers. In this paper Mr. Rogers described the obtaining of the supply from galleries near the river and wells and stated that so far there had been no trouble with diminishing amount nor with increasing content of iron or other minerals in spite of the increased draft. There was no discussion of this paper.

Another paper was read by Robert Spurr Weston in the absence of the authors, George C. Bunker and August G. Nolte, the former in charge and the latter assistant engineer in charge of water purification on the Panama Canal, the paper being entitled, "The Covering of Open Service Reservoirs in Which Filtered or Ground Waters Are Stored." The authors believed that in practically every case such reservoirs will ultimately have to be covered, since trouble with such water if not covered almost invariably occurred, and it was much cheaper to construct the covers when the balance of the reservoir was constructed than to add it later. Supporting the contention that trouble occurred with open reservoirs, the paper referred to the open reservoirs at St. Louis which had been giving trouble for more than seven years and for covers for which Commissioner Wall has yearly been asking several hundred thousand dollars. This paper was illustrated with a number of slides.

The session concluded with Allen Hazen's paper entitled "Some Additions to New England's Waterworks Plants," which also was read in the absence of the author, Mr. Pirnie substituting for Mr. Hazen. In this paper Mr. Hazen described briefly improvements at New Britain, Connecticut, where impounding reservoirs have been built to utilize the entire surface yielding of the drainage area and in addition wells have been installed; at Springfield, Mass., a duplicate slow sand filter plant is being constructed, doubling the capacity; Providence, R. I., is completing its new gravity supply and studies are being made for filtration of it, it being probable that mechanical filtration will be employed both because of the amount of color in the water and of the lack of available area for slow sand filters; it being proposed also to aerate both before and after filtration to remove taste and odor and also reduce carbonic acid and avoid red water troubles. Included in the paper, although not in New England, were Albany and Poughkeepesie, New York, both of which have filtration plants with double treatment, scrubbers being used. The Albany plant has been demoralized and the scrubbers become badly clogged and an entire overhauling is necessary, although ultimately a supply will probably be obtained from some source more favorable than the Hudson river.

In the afternoon Frederick I. Winslow of Framingham, Mass., discussed the subject of the "Care of Large Watersheds," this including tree planting and forestry, sanitary control and other features of the care of the watersheds of the Boston Metropolitan District. He recommended white pine for planting, commenting upon which in the discussion Mr. Diven stated that the Conservation Commission of New York advised red pine instead of white because of the white pine blister. It was believed however that by thoroughly eliminating gooseberry and currant bushes for an area of at least 500 feet from the trees, the blister could be prevented. Mr. Weston stated that the Scotch pine had given excellent results on

42nd Annual Convention New England Water Works Association
Ticonderoga N.Y. Sept. 18-21 1922
Photo by W. Wallace Kingsbury Inc. N.Y.

MEMBERS AND GUESTS AT THE FORTY-SECOND CONVENTION OF THE NEW ENGLAND WATER WORKS ASSOCIATION TAKEN AT PORT KENT, JUST AFTER LANDING FROM THE STEAMER TICONDEROGA, ON THEIR WAY TO THE AUSABLE CHASM.

the Pequannock shed. In Haverhill, Mass., according to A. L. Sawyer, good success was had with both white and Scotch pine. Boating and fishing were strictly prohibited on the reservoirs of this city.

A series of papers describing the new filter plant of Cambridge, Mass., was then read, Col. George A. Johnson reading the principal one entitled "Rapid Sand Filtration at Cambridge," followed by Mr. Stevens, who described the construction details and read a paper by Mr. Smulski describing the system of reinforcement used in the flat slab roofs over the filters, and finally one by ex-Mayor Goode dealing with the operation of plant. This plant was said by Mr. Johnson to be the first rapid sand filter plant in the state of Massachusetts, in addition to which it also contained several unusual features, although in the main it followed standard practice. The capacity was 14,000,000 gallons a day. The wash water is returned to the sedimentation basin, taking with it all of the suspended matter and thus conserving the water. The water is chlorinated after filtration. In the discussion, W. C. Hawley said that in the filters of his company, built in 1909-1910, the wash water is returned to the sedimentation basin but is first partly clarified in a separate settling basin, the result of this being a loss in washing filters of only 0.1% of the amount of water filtered. The wash water after settling was found to be better than the raw water with which it mingled in the sedimentation basin. Mr. Saville gave some facts with reference to the Hartford filters, referring to a friendly discussion between himself and Mr. Johnson relative to the cost of operation of that plant.

The final paper of the afternoon session was one by Harry U. Fuller, chief engineer of the Portland Water District, in which he described the laying of a 16-inch cast-iron water main under Portland's harbor. Mr. Fuller was given a vote of thanks for the paper since he was not a member of the Society. The method used was somewhat similar to that employed by New York City in laying pipe across the Narrows to Staten Island, a large wooden cradle being used down which the pipe slid into a trench previously excavated for it, the joints being made above water, every third joint being a flexible joint similar to those used by the Boston Metropolitan District. One of the questions arising in preparing the plans was whether the pipe would freeze in the cold weather of Maine, the harbor water frequently reaching the temperature of 23 degrees in winter. However, cans of fresh water buried in the salt water marshes along the shore with a 6-inch covering did not freeze and, as it was proposed to give this pipe a 3-foot covering, it was believed that there would be no difficulty from this cause. In crossing the channel the greatest speed was necessary to prevent holding up traffic and sixteen lengths of pipe were laid in ten hours, which was the maximum speed attained.

In the evening Frank A. Mazzur, mechanical engineer of Boston, read a paper entitled "The Selection of Pumping Equipment from the Standpoint of Station Economy." This paper was highly commended and we expect to publish it in an early issue. Mr. Mazzur compared a crank and flywheel high-duty engine, with a duty of 124,000,000 but with high cost, with a steam turbine centrifugal of low cost and requiring small area but with a duty of not over 100,000,000; also with an electric drive, which is not generally economical as an addition to a steam plant. The Diesel oil engine has been improved much since before the war in dependability and economy, and the duties now are greater than that of any steam pump. In general, Mr. Mazzur considered the oil engine as the most economical, especially in fuel cost. There was considerable discussion of this paper and numerous questions asked, most of the speakers agreeing that the Diesel engine was deserving of the high opinion expressed by Mr. Mazzur. One or two speakers expressed the opinion that the saving often claimed for the electrically driven pump in not requiring the presence of an attendant was not found to work out in practice, most plants furnishing an attendant.

George W. Batchelder, water commissioner of Worcester, Mass., described the reservoirs of that city, present and proposed, there being nine such reservoirs, which were shown by lantern slides. He stated that fifteen men are employed in maintaining them. Incidentally he remarked that during the winter, hydrants are inspected once every four days.

"Some Applications of the Venturi Principle" were described by Frederick N. Connet, chief engineer of the Builders Iron Foundry. Mr. Connet described uses that were common in waterworks plants and also a number that were possible but not yet in common use. He stated that Venturi meters could be used to advantage at ten different points in a mechanical filter plant.

THURSDAY EVENING

Thursday evening was set aside as superintendents' session and was opened with a paper by Frank A. Marston on "Hydrant Connections for Fire Engines," referring especially to the desirability of the 4½-inch connection. One strong argument in favor of supplying such connections on fire hydrants is that they are called for by the Underwriters Association. Mr. Hawley stated, however, that where pressures were high he was afraid of the 4½-inch connection. Instances were given of fire hydrants that were shaken loose from their connection by vibration due to a discharge through a 4½-inch connection. Mr. Marston said that considerable trouble had been found with water hammer or vibration in the use of such connection in Boston but almost invariably with a certain steam fire engine using a reciprocating pump.

A discussion followed covering various points connected with fire hydrants, some of the superintendents stating that in their cities one or more men connected with the waterworks department are carried as call men in the fire department and are supposed to be on hand to aid the firemen in the opening and closing of hydrants or in case of any other difficulty with the water supply.

Sydney Lee Ruggles, city engineer of Barre, Vermont, then described and illustrated on the screen experiences in eliminating water hammer from a high pressure regulating valve and also in laying Universal pipe on curves, with lantern slides showing such pipe laid on curves of about 200-foot radius without difficulty.

There followed a series of discussions on questions that had been suggested, these including

"Standardization of Water Meter Registers," "Use of Brass Pipe for Services," "Protection of Watermains Crossing Bridges," "Should Valve Boxes Be Placed at the Main or the Curb?" Discussion of the remaining questions was prevented by the lateness of the hour.

The subject of "Water Meter Registers" was introduced by Mr. Hawley, who stated that a water company in his district, in preparing to send to consumers cards with illustrations of dials and instructions for reading water meters, found that there were great variations in the arrangement of dials, some reading from left to right and others from right to left and that this difference was the cause of considerable confusion.He suggested that it would be a good plan to standardize water meter dials and it was decided by the members to revive the Committee on Meter Standardization and instruct it to cooperate with a similar committee of the American Waterworks Association in an effort to agree upon a standard form for meter registers; R. K. Blanchard of the Meter Manufacturers Committee stating that the manufacturers would be only too glad to adopt a standard instead of the eleven different styles now in use, if the societies would agree on what they wanted.

When the subject of brass pipe for services was discussed, Mr. Heffernan expressed the opinion that the cost of these would be prohibitive, to which Mr. Diven replied that the cost was about that of 2-A lead pipe. Several other members discussed the matter of services, including those of steel and of iron.

Concerning the necessity of protecting watermains crossing bridges, most of those speaking seemed to think there was little danger of freezing where there was circulation of water through the pipe, although one or two members described constructions employed by them for protecting pipe.

The question, "Should valve boxes be placed at the main or the curb?" seemed to be generally considered an unnecessary one, as no instance of service valve boxes in the street could be cited except in Worcester, Mass., and no very logical defense of the practice even there was presented.

FRIDAY'S SESSIONS

Friday was Manufacturers Day, the morning session being devoted to papers by manufacturers describing some features of their products or the use of them. Three reels of moving pictures were shown by A. A. Gatheman by which an excellent idea was given of the manufacture of wrought iron pipe in the A. M. Byers Company's plant. It had been proposed to show the manufacture of steel pipe by the National Tube Company, a paper with slides being down on the program for the afternoon, but it was decided to postpone this to a later meeting.

Payne Dean of Payne Dean, Ltd., gave a talk on "Testing, Maintenance and Operation of Large Gate Valves," in which he cited instances where the necessity of hand operation of these valves occasioned risk to property and lives, while it always involved hours of hard labor, which could be avoided by the use of a valve-operating truck which operated such valve by motor, or by the electrical control system for closing valves at a distance.

Under the title of "Records of Stream Flow; their Use and the Best Methods for Obtaining Them for Municipal and Industrial Purposes," C. C. Covert of W. & L. E. Gurley, described methods employed for obtaining such records, chiefly those of the U. S. Geological Survey, the paper being very similar to one read this year before the American Waterworks Association.

The last paper of the convention was one by Gilbert H. Pratt of the Wallace & Tiernan Company, describing some of the latest developments in chlorine control apparatus. Mr. Pratt illustrated his talk with lantern slides, showing among others the largest chlorination plant in the world, being the one at the Cleveland sewage treatment plant, which has a capacity of feeding 8 tons of chlorine in 24 hours to the sewage effluent before discharging into the lake.

Only a few attended the afternoon session, which consisted of the reading of the reports of the secretary, treasurer and editor and the president's address.

Short Courses in Highway Engineering

The University of Michigan announces the schedule of graduate short period courses in highway engineering and highway transport for the winter of 1923-24. Attendance on this course has steadily increased from 29 four years ago to 110 last winter. The average age of the men in attendance last winter was 27 years, varying from 23 to 56. They came from state, county and municipal highway departments, the U. S. Bureau of Public Roads, the offices of engineers and contractors, university faculties, companies manufacturing motor trucks and highway machinery and materials and the field of highway transport.

The course is divided into seven parts of two weeks each, beginning Dec. 3d and ending March 14th, with four days, February 11th to 14th, devoted to the Tenth Annual Michigan Conference on Highway Engineering. The several subjects will be in charge of Professors Blanchard, Swinton, Bateman, Riggs, Worley, Gram, Cissel and Lay.

Highway Patrol in Pennsylvania

Under the present law any of the 10,000 employees of the Pennsylvania State Highway Department can be deputized by the Secretary to serve notice on violators of the traffic rules and State troopers are now training nearly 100 men of the highway patrol in the methods used by special police. With the aid of these, an effort will be made to make the highways of Pennsylvania unsafe places for violators of the law.

Some of the infractions of highway regulations which the highway patrol will specially look out for are: Parking along improved sections of the state highways; passing other vehicles on hills and curves; lamps out of focus or with high candlepower; overloaded trucks; unlicensed operators; drivers who prevent operation of two-way traffic, and those who drive while under the influence of liquor. The Highway Department will revoke the license of drivers where the violation is sufficiently serious.

Street Maintenance in Richmond

By J. W. Eubank*

Organization of the Department and work done in repairing gravel, concrete, spall, asphalt block and asphalt concrete surfaces on 204 miles of paved and gravelled streets

The Street Maintenance Bureau of Richmond, Virginia, is one of two bureaus of the Department of Maintenance and Street Cleaning and is in charge of a superintendent who supervises the maintenance of all streets, sidewalks and bridge surfaces to keep them in a safe and usable condition; the installation of drain pipes for removing surface water at street intersections; resurfacing, reshaping and oiling gravel road beds; building gravel roads; improving old pavements by relaying, resurfacing or replacing small portions that are worn out; treating earth and gravel roads with dust-laying materials; resetting and replacing curbs, gutters and sidewalks; building barricades, bulkheads, etc.; grading and cindering alleys, streets and sidewalks; inspection of all work done under permits granted by the Bureau pertaining to openings in the surface or construction work within the boundaries of the city highways; and reporting on all complaints made by citizens concerning street surface conditions. The area covered by this supervision is approximately 25 square miles. The superintendent is aided by an assistant, two foremen, a sub-foreman, two inspectors and a contractor. The average force of laborers is about 135.

There are in the city 376 miles of dedicated streets, of which 67 miles is smooth pavement, 47 miles is stone pavement, 90 miles is bank gravel and 152 miles earth and cinder surface.

The organization is divided into the following units: Truck and steam shovel outfit, one foreman and 14 laborers, for general hauling and maintenance and building gravel and cinder roadways;

Oiling and dragging outfit, one foreman and eight laborers, treating roads with dust-layer, dragging and scraping earth roads;

Bridge and culvert outfit, three laborers, looking after the installation of drain pipes and open drains, repairing bridges, etc.;

Grading outfit, one foreman and six laborers, looking after the grading of alleys, sidewalks and streets;

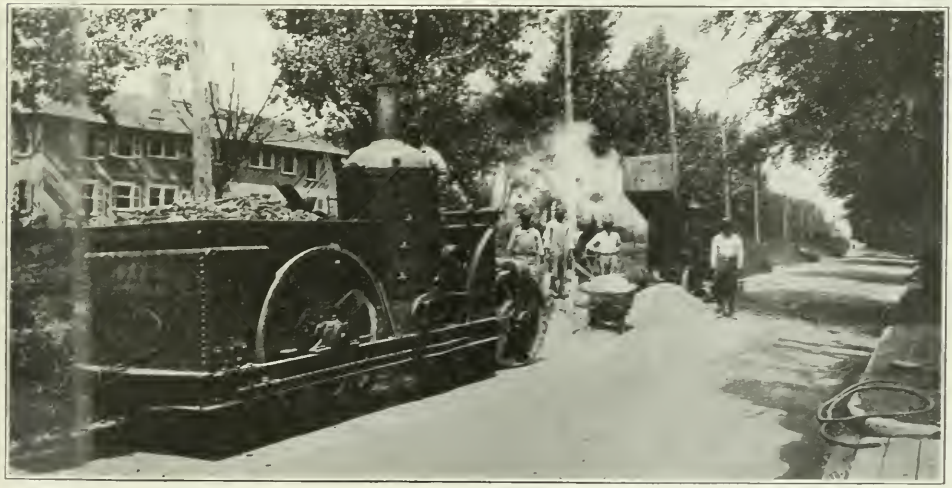
Scarifier-roller outfit, six laborers, scarifying, reshaping and rolling gravel roadways;

Emergency force, three laborers, answering emergency calls for minor repairs to sidewalks, alleys, streets, etc.;

Repairing smooth pavement, three foremen and sixty-five laborers.

All materials, equipment and tools are furnished by the Bureau, while the contractor contracts for labor, doing the work outlined by the superintendent on all improved pavements, including pavements disturbed by the various departments in making service connections.

*Chief, Bureau of Repairs, Maintenance and Cleaning, Richmond, Va.



EQUIPMENT USED FOR REPAIRING ASPHALTIC CONCRETE SURFACES.

The inspectors look after all work done under permit pertaining to the restoration of street surfaces, construction of vaults, cellar doors and sidewalks, erecting poles, gasoline pumps and banners, and reporting on bad conditions of any street surfaces.

Contracting for maintenance of improved pavement has proven to be the best method tried for handling this work. It takes less inspection, gives us the opportunity to employ better skilled workmen for paving work, does away with the many contentions that are usually caused by contractors, and fixes where it belongs, the responsibility for the maintenance of the street surfaces due to trench work. Work done under this plan is such that a trench seldom if ever settles after being repaved and the cost is 25 per cent. less than any other method heretofore used.

REPAIRING GRAVELLED ROADWAYS.

Heavy hauling and rapidly moving vehicles cause such disintegration of gravelled roads that after four months a good, smooth surface is filled with pot holes. Such surface is scarified with a steam roller having a scarifier attachment, followed by a Fordson attached to a Baker grader which pushes the loose material from each side to the center and then pulls it back again, this operation stirring up the material and distributing it evenly, also bringing the large gravel to the top where it is gleaned off and hauled away. If it is dry, the road is then thoroughly wet and any new material needed to give the surface the proper crown is supplied. The surface is then again shaped with the road machine and rolled thoroughly, after which in many cases 1-1/2 pounds per square yard of calcium chloride is applied or, if the amount of traffic warrants it, an application of asphalt oil is used.

Some of the most important instances of oiling roadways have been surface-treating the gravelled roadways around Shields Lake and William Byrd Park with a cold application of Barber asphalt oil, 1/2-gallon to the square yard, covered with 25 pounds of stone chips per square yard; surface treating Hull street and Broad Rock road with a hot and cold application of Tarvia B and A covered with pea gravel. In the latter treatment, after thoroughly cleaning the surface to be oiled, 1/2-gallon of cold B oil per square yard was applied and allowed to penetrate, when it was followed by a hot application of A oil, 35 gallons to the square yard, which was immediately covered with 45 pounds of pea gravel. Many old main thoroughfares have been re-oiled with a cold application of from 1/4 to 1/2 gallon per square yard, depending upon the quantity the surface would hold, and then covered with chips and asphalt block.

REPAIRING CONCRETE SURFACES.

Concrete gutters, walks and roadways when worn very badly are replaced with a very dry mixture of 1:2:4 concrete rammed thoroughly before trowelling; but in many cases where roadways and gutters have worn in small holes or been gouged out at the joints, these places are repaired with rock asphalt; while in some cases deep holes in the gutters are repaired with a cold patch material which is kept already mixed. The cold oils used are Tarvia K. P. and Kolmend prepared by the U. S. Asphalt Refining Company. Rock asphalt has proven to be the best patching material we have used. Any hole that is over 2 inches deep is filled with stone to within 2 inches of the surface and cold patch material used for 2 inches depth only for the sake of economy. The edges of the holes are painted with asphalt and the patching material placed and tamped and ironed out by traffic.

Expansion joints and cracks in these roads are gone over in the Spring, being cleaned out thoroughly with sharp tools and brooms and then filled with an asphalt filler of approximately 45 penetration. Better results seem to have been obtained by doing this work in the Spring than in the Fall because the dryness of the ground gives deeper and better bond to the concrete.

REPAIRS TO SPALL PAVEMENT.

A marked improvement has been obtained by relaying old stone pavement with asphalt filler on five of the streets of the city, the new surface in some cases resembling sheet pavement. This repaving not only produces a better appearance and makes the street easier to clean, but adds to the comfort of motorists, saves wear on vehicles, makes the stones more difficult to displace and saves a great deal of minor maintenance. Four blocks of the north side of Main street, originally paved with Belgian block on a concrete base, had been disturbed by sewer construction. After the base had been restored the blocks were relaid at an angle of 22½ degrees with the curb on 2 inches of dry cement-sand grout mixed 1:3 and sprinkled; the joints were

MIXER USED FOR PREPARING TOPEKA MIX.

(Continued on page 328)

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Inconsistencies in Bidding

Contractors as a class are more intelligent and contracting is on a more substantial basis and more scientifically performed than was the case a generation ago. This being so, we can but wonder at some of the bids that are submitted from time to time.

Two recent bids on sewer work will serve as illustrations. At a letting in Washington, bids were received for trench excavation and backfilling, furnishing and laying pipe being separate, and bids being received for different depths of trench. As difficulty and cost of excavation increase more rapidly than the depth, so did the price bid by most contractors; one, for example, bidding 90 cts. for 4 to 6 ft., $2.80 for 10 to 12 feet., and $10 for 16 to 18 ft., while another bid 80 cts., $2.60 and $8 for the same items. But the successful bidder's figures were 85 cts., $1.20 and $1.65 respectively—less than double the price for four times the depth, instead of seven to eleven times as in the other bids.

The other case was similar, the low bidder offering to lay 24 in. pipe in an 8 to 10-foot trench for the same price as in a 4 to 6-foot one, although the other bidders increased their figures by an average of 38% for the greater depth, or $1.23 per lineal foot.

In each of these cases the items referred to were the chief ones of the contract and there was no unbalanced bidding evident in the figures submitted, except as those given above might be so considered.

Fortunately, the large majority of contractors bid with much greater consistency and intelligence, or engineers would soon give up as useless the dividing of work into units of reasonably uniform cost as an aid to contractors in making business-like bids rather than guesses or gambles.

Garbage Reduction Expensive

The city of Chicago has for several years been disposing of its garbage by reduction at a city-owned and operated plant, part of the garbage being hauled directly to the plant and part by boat from loading stations. Last year extensive improvements and extensions of the plant were completed. We have not the figure for the total cost of these, but the amount paid out on these improvements last year was more than $79,000. These improvements were completed so that the improved plant was in full operation by June. Taking the operating costs and revenues for the last seven months of the year, we find that 71,368 tons of garbage were treated, at an average cost, including the operating expenses only, of $5.93 a ton. The revenue from all sources averaged $1.79 a ton, giving a net cost, operating expenses only, of $4.14. We have not readily at hand the total cost of the plant, but interest and depreciation on that would probably amount to as much more. In addition to these costs, we have the cost of collection of $5.57 per ton, giving the total expenditure for the seven months of $11.50 a ton.

It is pointed out in the report that, presumably because of the improvements made, the cost of operating the plant was less than during the previous year, although the amount of garbage re-

ceived was greater, the net operating cost per ton of garbage in 1921 having been $6.04.

With this financial condition of affairs known, the question naturally suggests itself why the plant was not abandoned entirely instead of spending over $79,000 on improvements.

Chicago is so located that it is practically impossible to dispose of the garbage by dumping and, considering the enormous amount of garbage involved, it might be questioned whether hog-feeding at a sufficient distance from the city to provide against nuisance would be practicable. There does not seem much question, however, that destruction of the garbage in incinerators or destructors could be secured at a considerably less operating cost than $4.14 a ton—in fact, the cost might well be so much less than this that the saving would pay for the new incinerators in a very short time. Incineration would also probably make possible an additional saving in that a number of incinerators could be scattered throughout or around the outskirts of the city so as to reduce considerably the average haul and thus effect a considerable reduction in the collection cost, which totalled nearly $600,000 last year, $94,000 of which was the cost of operating the loading stations and transporting the garbage by boat.

The actual expenditures for collection and reduction of garbage last year exceeded $1,350,000, or, deducting the revenue, the net cost exceeded $1,213,000. This sum certainly is large enough to offer an inducement for a serious consideration of the question with a view to adopting some much more economical method whereby a saving could probably be made of at least $500,000 a year. It is certainly to be hoped, for the sake of the taxpayers, that something of this kind will be done rather than continuing to invest the city's funds in extensions of what shows no hope of being anything but a losing proposition.

Chicago is but an extreme illustration of what all reduction plants have been experiencing during the past two or three years. We believe all, without exception, have operated at a loss, and there seems to be no hope for improvement unless the demand for garbage grease and tankage increases very materially, with a resulting rise in prices paid for them.

Contractor Profits by Winter Work

In the Fall of 1922 the commissioner of state highways of Minnesota advertised for bids on a number of projects to be carried on during the Winter, although this state is far within the region of heavy snows. Among these was a 15-mile stretch of gravelling which was let to the Connelly Contracting Company of St. Paul. The engineer's estimate on this work was $83,000, but the successful contractor's bid was $49,900, and the contractors put through the contract and presumably made money by superior organization.

The contractors had already reinforced their truck frames with heavy steel I-beams. As the state specifications required that the gravel be hauled in loads that were level with the top of the truck bodies, the contractors built up their truck bodies one-third more than the original height in order to haul as large loads as practicable, the hauling being paid for by the yard-mile, 17c for the first mile and 4c for each additional mile. The average length of haul was 12 miles.

Another item of preparedness was the fixing of the road over which the hauling had to be done during the Fall, shapers, graders and tractors being used so that when freezing weather arrived the 15-mile stretch was smooth and hard and traversed as easily by the trucks as though paved. The contractors also leased a farmhouse, a hotel, restaurant and garage for insuring the proper living conditions of their employees and the keeping of their trucks, tractors, graders, steam shovels, etc., in proper condition by expert mechanics who were continually on the job. As they used $5,000 worth of gasoline a month, the Standard Oil Company installed a 1,000-gallon filling station at the farmhouse, which was located near the gravel pit.

The men were worked in two 8-hour shifts and thus the expensive trucks and other equipment were kept operating 16 hours out of the 24. By keeping men and equipment co-ordinated and working to advantage, 22,400 yards of gravel were hauled and spread during the severe Winter conditions at the remarkably low cost indicated.

Street Cleaning Statistics

Figures and other information from about two hundred cities concerning the expenditure for street cleaning, cleaning of sidewalks, snow removal, use of hand brooms, machine brooms, pick-up sweepers, flushing machines, flushing by hose, and other details

From questionnaires returned to this office during the past month we have compiled exceedingly interesting and valuable information concerning the methods and appliances used for street cleaning and the disposal of street cleanings and garbage in about two hundred cities in all parts of the country. The tabulation of disposal data is not included this month because of limitations of space, but will be given in the November issue, together with a summary and analysis of much of the tabulated information.

STREET CLEANING STATISTICS—I.

City	Expenditure Last Year	Notes on Expenditure
Alabama:		
Florence	No record	Done by garbage department.
Gadsden	$3,239.11	.....
Talladega	About $7 per day	One man and two 1-horse wagons daily. 3 extra teams after rains.
Arizona:		
Tucson	$5,543.00	$130 for brooms; balance wages at $2.50 per day.
Arkansas:		
Fayetteville	2,500.00	Hand sweeping, shoveling gutters, flushing with fire hose.
California:		
Monterey	4,500.00	Labor and teams.
Napa	3,200.00	Hand brooms and small cart daily in business section; whole street force Saturday in residence section with hand brooms.
Redlands	5,992.00	.....
Santa Ana	37,526.00	$11,162 for street sweeping, $4,305 disposal of sweepings, $4,805 disposal of street trash; $17,254 disposal of garbage, paper and cans.
So. Pasadena	5,000.00	.....
Colorado:		
Denver	225,000.00	Sweeping paved streets and alleys, flushing paved streets, cutting and burning weeds, cleaning dirt alleys once a year.
Connecticut:		
Hartford	213,821	Cleaning improved pavement. $160,756; macadam, $53,066; includes snow removal.
New Britain	13,974.00	10 patrolmen on pavements, 5 men and teams 5 summer months on macadam; extra gang on leaves in October.
New Haven	110,000.00	Includes care of public dumps, removing refuse from police stations and other public buildings, and snow removal.
New London	18,000.00	$8,000 for sweeping, $10,000 for snow removal.
Willimantic	8,000.00	.....
Florida:		
Key West	6,000.00	.....
St. Petersburg	4,078.00	$2,440 for horse-drawn sweeper, $1,638 for teams.
Georgia:		
La Grange	9,000.00	Appropriation for 1923, includes cleaning and maintaining storm sewers.
Idaho:		
Lewiston	$16,000.00	White-wings, street washing and garbage collection.
Twin Falls	5,000.00	Absence of storm sewers & surrounding desert increases cost.
Illinois:		
Canton	3,000.00	.....
Freeport	5,000.00	.....
Kankakee	30,328.00	Also $22,927 for alley cleaning and garbage collection and $4,565 for care of parks.
Oak Park	19,660.00	Sweeping, $8,611; hauling, $9,246; miscellaneous, $1803.
Quincy	6,700.00	Estimated, entire paved area, Main St. by white wings.
Sterling	10,952.00	Includes removing ashes and cans and repairing streets.
Indiana:		
Bedford	14,000.00	6 miles of brick streets, 79 miles mostly gravel and macadam.
Brazil	1,500.00	Including sweeping, flushing and collecting leaves on paved sts.
Elkhart	18,000.00	Total expenditure of Street Department.
Gary	34,000.00	Does not include superintendent of streets.
Hartford City	1,200.00	.....
Indianapolis	150,000.00	Average cost of cleaning, $390 per mile.
Lafayette	12,984.00	Street sweeping, $7,995; gutter cleaning, $4,989.
La Porte	12,000.00	10 white wings at $3.50 per day.
Lebanon	3,500.00	.....
Shelbyville	7,000.00	About $2,500 for cleaning 2½ miles of business section with horse-drawn sweeper. Other 28 mi. of street swept occasionally.
South Bend	40,000.00	Accounts of Street Department not segregated.
Terre Haute	39,000.00	.....
Wabash	5,200.00	Lahor, $5,100, equipment, $100.
Iowa:		
Cedar Rapids	18,112.00	One flusher with pick-up gang and 12 white wings.
Charles City	2,913.00	Three white wings at $65 per month in business district, horse drawn broom once a week.
Des Moines	78,170.00	Hand sweeping, flushing and snow removal.
Keokuk	2,080.00	Contract for cleaning, flushing and sprinkling, 26 weeks at $80.
Ottumwa	5,703.00	Broom cleaning, $4,681; flushing, $1,022. 30% in residence district.
Kansas:		
Iola	4,123.00	.....
Pratt	1,500.00	.....
Kentucky:		
Ft. Thomas	.....	Little cleaning done; included in street maintenance cost.
Louisville	243,672.00	.....
Mayfield	2,628.00	Does not include extra expense after celebrations, shows, etc.
Maine:		
Bangor	12,662.00	.....
Rockland	3,619.00	Teams used for fire also so charged to Fire Department and men charged to street cleaning.
Massachusetts:		
Adams	6,000.00	.....
Brockton	29,411.00	Cleaning gutters, $4,926; watering, $1,204; cleaning basins, $3,363; removing snow, $5,962; flushers, $465; scraping, $2,594; sweeping, $8,998.
Cambridge	80,850.00	Labor, $70,039; tools, $196; use of horses, $10,614.
Concord	4,361.84	.....
Gardner	8,000.00	.....
Haverhill	24,000.00	1 Elgin sweeper and hokey pokey men included.
Hudson	8,000.00	Includes snow removal and 1 white wing.
Natick	3,000.00	Includes cleaning basins; one man with push cart in centre of city all the time, 10 men and 2 or 3 teams one-half day a week.
Northbridge	2,300.00	.....
Orange	.....	$15 a week for man with 2-wheel cart, keeps clean the square and ¼ mile from it out each street.
Reading	600.00	Police work in main square; only hand-broomed and shoveled into Ford dump twice a week by 2 men
Michigan:		
Alma	1,744.64	Rubbish removal (cans, ashes, etc.) cost $1,877.04; flushing (driver, repairs, oil, gas, harness, shoeing, etc.), 1,745
Ann Arbor	21½c. per 1,000 sq. yd.	1 Elgin pickup sweeper.
Flint	32,908.54	$2,188.67 for snow removal. Balance on paved street cleaning.
Highland Park	24,857.00	Snow cleaning and all street cleaning.
Holland	8,000.00	Includes street flusher and four sweepers.
Manistique	900.00	1 white wing.
Muskegon	20,000.00	.....
Pontiac	16,000.00	.....
Minnesota:		
Cloquet	2,580.10	Cleaning streets.
	3,119.40	Removing snow.
Rochester	5,238.71	Flushing, cost.
	5,750.76	Pickup men, 2-yd. dump wagons, 1¼ miles average haul.
St. Paul	250,000.00	Includes $30,000 sewer cleaning, $10,000 dump maintenance.
Missouri:		
Jefferson City	500.00	.....
Kansas City	337,528.51	Hand-brooming, push carts and dump carts.
Marshall	.....	1 man and cart—gutters cleaned 2 or 3 times a year.
St. Joseph	5,000.00	Sweeping and flushing.
Sedalia	3,300.00	By contract.
Montana:		
Bozeman	1,900.00	$675 for hand cleaning Main St.; $1,225 from various cleaning and flushing districts, 75% of which is charged against abutting property.
Lewistown	4,000.00	Flushing and hauling off twice a week.
Livingston	5,000.00	Two men continuously with Fordson tractor, scraper and wagon.
Nebraska:		
Lincoln	23,291.67	White wings, $7,490.48; outside cleaning, $13,953.13.
Norfolk	5,500.00	.....
New Hampshire:		
Nashua	12,784.28	.....
New Jersey:		
Asbury Park	30,000.00	.....
Irvington	5,000.00	.....
Salem	3,000.00	.....
New Mexico:		
Albuquerque	12,000.00	White wings.
New York:		
Endicott	3,454.00	Hand brooms and scrapers on pavement, $1,616; hauling snow, $396; cleaning crosswalks, $354; plowing snow, $150; flushing and sprinkling, $841.
Gloversville	6,000.	.....
Johnson City	3,000.00	Cart pickup men, $1,500; balance flushing and truck.
Norwich	1,985.60	.....
Tonawanda	2,100.00	.....

STREET CLEANING STATISTICS—I.

City	Expenditure Last Year	Notes on Expenditure
North Carolina:		
Burlington	8,000.00	Elgin street sweeper.
Gastonia	7,802.25	Street cleaning labor, $6,331.25; supplies, $1,471.
Thomasville	1,000.00	Horse-drawn sweepers two nights per week.
North Dakota:		
Fargo	36,652.00	Maintenance, salaries, tools, small equipment.
Ohio:		
Akron	121,582.00	.....
Chillicothe	8,000.00	Cleaning and flushing.
Cincinnati	337,290.00	Street cleaning, $131,576; snow removal, $3,397; ash and rubbish, $172,860; sewer and basin cleaning, $29,457.
Circleville	1,000.00	.....
Dayton	39,249.25	White wings in business district, hand brooms on remainder and piled for truck hauling.
Delaware	2,500.00	Flushing, hand-sweeping and hauling.
E. Youngstown	20,000.00	7 miles streets hand cleaned.
Findlay	5,000.00	Salaries and equipment.
Fremont	1,200.00	.....
Lima	26,000.00	.....
Mansfield	12,374.22	.....
Middletown	8,205.70	Also $78 for equipment and approx. $1,200 for horse-feed.
Urbana	7,000.00	2 men, 52 weeks @ $24 and $25 each; approx. 5 miles paved streets flushed every 3 days at cost, $600 per month.
Zanesville	13,000.00	Supt. salary, $1,500; laborers, $7,500; equipment and supplies, $4,000.
Oklahoma:		
Blackwell	25.00	Hand swept and hauled by truck.
Chickasha	6,700.00	Flushing and trucking, white wings and carts.
Enid	4,000.00	Salaries, $3,240; horse feed, $550; repairs to cart, etc., $160.
Oregon:		
Astoria	30,000.00	Includes maintenance as well as cleaning.
The Dalles	2,180.00	$1,680 for 2 street cleaners on business streets; $500 for sprinkling once a week.
Pennsylvania:		
Ashland	Approx. 4,000.00	.....
Butler	Approx. 1,500.00	Elgin sweeper and white wings.
Clairton	3,150.00	3 miles streets cleaned regularly, 25 miles when needed.
Clearfield	Approx. 1,500.00	.....
Dormont	1,500.00	.....
Forest City	1,700.00	Excessive owing to flood.
Freeland	1,400.00	Paved streets, $960; unpaved, $440.
Lancaster	14,000.00	.....
Meadville	5,462.59	Operation of motor sweeper, 3 white wings and extra labor.
Munhall	3,000.00	2 men, brooms, push buggy.
Norristown	Approx. 600.00	Hand sweeping center business streets once a week.
Philadelphia	4,551,599.00	$2,317,045 for street cleaning; $1,514,494 for ashes and rubbish; garbage, $686,594; $39,466 net loss reduction plant.
Rankin	4,000.00	.....
Ridgeway	500.00	.....
Steelton	4,119.00	Sweeping, $2,923; general cleaning, $1,196; garbage collection, $7,591.
Swoyerville	1,500.00	.....
Woodlawn	2,664.00	8 sweepers every day, also flushing machine.
Rhode Island:		
Pawtucket	59,097.00	Sweeping pavements, $31,934; cleaning paved gutters (mostly waterbound macadam), $18,415; snow and ice removal, $8,748.
South Carolina:		
Chester	2,500.00	Man with flusher, 300 days @ $2.25—$675; 2 men with brooms and carts, 300 days, each, @ $1.25—$750; teams, brooms, etc., approximately, $1,075.
Orangeburg	3,200.00	.....
South Dakota:		
Lead	575.00	Hose flushing & hand sweeping.
Rapid City	1,480.00	.....
Tennessee:		
Jackson	5,200.00	.....
Kingsport	3,380.00	Hand scraper blade 5 ft. long. Cost includes garbage collection. Ford truck used to remove refuse.
Murfreesboro	5,000.00	.....
Texas:		
Amarillo	6,000.00	Does not include alley cleaning and trash and garbage removal.
Burkburnett	2,000.00	Sanitary officers' salaries etc. Business sections cleaned by merchants.
Childress	900.00	.....
Del Rio	1,200.00	.....
Eastland	2,000.00	Hand sweeping $1500; wagons cleaning gutters $500.
San Angelo	2,100.00	Operating one horse-drawn machine broom.
Vermont:		
Brattleboro	2,000.00	2 men @ $15 a week. Team and extra man clean up main streets, approximately 25 miles.
Rutland	2,520.00	.....
Virginia:		
Danville	12,086.89	27,331,423 sq. yd. streets swept.
Fredericksburg	4,200.00	.....
Harrisburg	5,000.00	Cleaning streets and hauling garbage to dump.
Newport News	10,000.00	Patrols, $560; horse-drawn sweeping, $4,000; equipment, repairs and replacements, $600; labor, $4,840; Elgin pickup machine installed June, 1923, $6,500.
Richmond	85,431.53	Street cleaning cost.
Staunton	3,000.00	.....
Washington:		
Aberdeen	5,017.25	Labor, $4,390; water, $550; supplies, $57; equipment maintenance, $20.
Walla Walla	9,200.00	Flusher driver, $2,500; pick-up laborers, $5,000; repairs to equipment, $700; flushing water, $1,000.
West Virginia:		
Clarksburg	9,034.97	.....
Fairmont	4,000.00	3 or 4 men with flushing machine and truck, principally in business section. Push brooms in gutters.
Wisconsin:		
Beaver	3,500.00	Part of the work done by fire teams.
Kaukauna	2,089.74	Snow and ice removal, $1,083; street sprinkling (water and oil), $3,034.
Kenosha	58,230.00	.....
Marinette	10,000.00	Cleaning and repairs included.
Wisconsin Rapids	2,400.00	Cost approximates 22c. per 1,000 sq. yd.

(*Continued from page 324*)

then filled with hot gravel almost to the surface, following which a hot mix of two parts sand and three parts asphalt was poured in until the joints were full and then broomed over and covered with stone chips. At other locations the rough stones were relaid on the original sand cushion, the joints filled with gravel and asphalt as above and covered with stone chips and sand grits. About two gallons of asphalt were used to the square yard. The total cost of the work was about 75c per square yard.

REPAIRS TO ASPHALT BLOCK PAVEMENT.

Where cuts occur in asphalt block pavement, the pavement has been relaid with an asphalt filler that leaves a mat on the block, protecting from water and wear and giving the appearance of sheet pavement. In no case has this pavement settled over a trench after relaying. Some old asphalt block pavement was relaid with asphalt joint filler, which gave very good results and is a very simple and economical method of preserving this class of pavement. The cost of this work was 75c per square yard.

REPAIRS TO ASPHALTIC CONCRETE SURFACE.

It has been a somewhat perplexing problem to decide just what was the most practical method of repairing our asphalt concrete surfaces, which in many cases were irregular and worn due to burnt materials, while in other cases, especially on some of the main boulevards, high ridges and puffed up places had occurred because the base was slick and the mixture too fat. Moreover, we are constantly cutting into these surfaces for renewal of service pipes, etc. Replacement of

pavement over these cuts is done by this Bureau, which keeps an accurate account of the cost of the work and issues monthly statements to the various city departments or bureaus and companies or corporations.

This Spring there were approximately 6,000 square yards of the various types of sheet asphalt pavement to be repaired, and we decided to try on this work the Iroquois rapid mixer. This plant is mounted on a steel truck frame and can be hauled easily from point to point by a team or tractor or, better still, by the roller used on the work. This mixer is operated on the work without inconvenience to traffic.

The batches used by us were 500 pounds, consisting approximately of Topeka mix as follows: 135 pounds of stone, 200 pounds of coarse sand, 100 pounds of fine sand, 25 pounds of limestone dust and 40 pounds of Genasco liquid asphalt. The mineral aggregate was measured in boxes and struck off and put into the hopper, which is hoisted mechanically into the drum. The engine is then thrown into gear and asphalt is poured in while the paddles are revolving; immediately after which two pints of gasoline is thrown into the drum and ignited with a piece of burning waste attached to the end of a long stick. In about five or six minutes the gas and volatile matter in the asphalt is consumed and you get a batch of material that is thoroughly mixed and has a temperature of between 285 and 300 degrees F. There is absolutely no danger of burning the batch. The aggregate must be thoroughly dry, and our method is to heat the fine sand at the storage pile as it is hauled from the cars and store it under a shed, hauling it to the mixer as needed; this proving to be more economical than heating on the job.

Almost any kind of labor can be used to operate the mixer. Our gang consists of one roller man who acts as foreman, two men at the mixer, two men hauling materials to and from the mixer (concrete buggies are used for this purpose), one raker, and five men cutting out bad asphalt and painting edges of holes prior to putting in hot stuff.

Our average cost for patching this year to date is $1.16 per square yard, this including materials and all labor and truckage on operations. The sheet laid has varied from 1-1/2 to 2 inches thick and the work has been scattered over all sections of the city. The cost of materials and truckage was 80c a square yard and labor 45c a square yard, although on good days the cost of labor for mixing material has been as low as 21c per square yard, this not including the cost of cutting out old work. This plant has more than paid for itself in forty days of continuous use as compared to the old method of reheating old material and replacing it, while at its best the old material could not be relied upon. An 8-ton tandem roller has been used for rolling patches and they can hardly be discerned except that after heavy rains they show a little darker than the original pavement.

WORK DONE LAST YEAR.

During 1922 we oiled 12.6 miles of streets with an average width of 22.2 feet, at a cost of $1,429.42 per mile; scarified and reshaped and rolled 48.31 miles of gravel roads averaging 22.05 feet wide at a cost of $247.28 per mile; surfaced with gravel and built 14.09 miles of road averaging 20.1 feet wide at a cost of $1,350.46 per mile, or $1.03 per cubic yard in place. Approximately 6 miles of earth streets were improved with a layer of material from the Tredegar Iron Works to a depth of about 8 inches. This proved to be excellent material for unimproved roads, as it contains a large percentage of iron ore and when compacted will carry the heaviest class of traffic and does not dust up like cinders. In addition, 4.33 miles of earth roads were scarified, reshaped and rolled for an average width of 23.67 feet at a cost of $137.18 per mile. Ninety-two miles of roadways were shaped with a road machine at an average cost of $36.25 per mile; 5.55 miles of gravel roadways were treated with calcium chloride for an average width of 20.52 feet at a cost of $241.87 per mile. The calcium chloride treatment is very satisfactory, especially in dry weather, as it keeps down the dust by collecting moisture from the air and holds the material intact.

Device Used for Painting Center Line on Highway

The California Highway Commission, like those of several states, has this year adopted the practice of painting a line down the center of the highway as a device for furthering the safety of travel thereon by confining automobiles to their own side of the roadway. The illustration shows a white line being painted down the center of the highway south of San Francisco. In this work a simple device is used consisting of a paint receptacle carried on a three-wheel handtruck from which a hose leads to a paint brush attached to the front of the device just back of the front wheel. This brush applies the paint to the surface of the highway, and a second brush a few inches back of it spreads the paint to the proper width. A red chalk line is marked on the pavement ahead of the paint spreader to guide the path of the latter. A truck follows carrying wooden standards which are placed over the painted line about 15 feet apart to protect the paint from vehicles while it is fresh.

MARKING CENTER LINE OF CALIFORNIA ROAD.

STREET CLEANING STATISTICS—II

City	What percentage of sidewalks does city clean?	Snow Removed by City: From how many miles of streets?	Snow Removed by City: Methods and appliances used	Area of Streets on Which City Uses: Hand Brooms	Area of Streets on Which City Uses: Machine Brooms
Alabama:					
Florence	None	30	Shovels	Business district	None
Gadsden	25	None	.....	Gutters only	None
Talladega	None	.....	.....	2 or 3 mi.—scrapers	None
Arizona:					
Tucson	None	.....	.....	All pavements	None
Arkansas:					
Fayetteville	None	None	.....	35,000 sq. yd.	.....
California:					
Monterey	None	None	.....	Whole city	None
Napa	None	.....	.....	31,000 sq. yd. per day	None
Redlands	None	None	.....	30 miles gutters	.....
Santa Ana	None	None	.....	Entire paved area	Entire paved area
South Pasadena	None	.....	.....	40 miles	None
Colorado:					
Denver	None	25 miles	Trucks, teams, caterpillars and blades	150 downtown blocks	72 mi. paved sts.
Connecticut:					
Hartford	Park walks only	12 miles[b]	Teams, laborers, snowplows, caterpillar steam shovels, motor trucks	1,839,308 sq. yd.[c]	None
New Britain	None	Plow 50 miles remove 3 miles	Truck plows; hand shoveling to teams, trucks and trolley cars	.....	None
New Haven	Public bldgs. only	20 miles	Plows, steam shovels, trucks and trolley plows	All	None
New London	Public prop. only	3 miles	Hand shovel into trucks and carts	72,000 sq. yd.	None
Willimantic	None	25 miles	Motor plows and carts	5 miles	None
Florida:					
Key West	None	None	.....	All paved streets	None
St. Petersburg	None	.....	.....	20 blocks	None
Georgia:					
La Grange	None	.....	.....	6 miles gutters	None
Idaho:					
Lewiston	Business district	30 mi. sidewalks	Horse plow	3 miles	None
Twin Falls	All residence sts.	½ mile	Wagons	Corners and crossing gutters	None
Illinois:					
Canton	40	5 miles	Graders	15,000 sq. yd.	10 miles
Centralia	None	Little snow	.....	None	None
Freeport	None	None	.....	All	None
Kankakee	Snow only—all	Paved streets	Horse-drawn snow plows	12 miles	.....
Oak Park	Snow only—all	None	Horse plows	Gutters only	None
Quincy	2 miles	6 miles	Graders, teams and wagons	5 miles daily	None
Sterling	None	Going to in business district	.....	.....	.....
Winnetka	Snow only—all	None	Horse plows	Yes	8 blocks bus. dist.
Indiana:					
Bedford	None	Street crossings	Hand shovels	6 miles	None
Brazil	None	2 miles	Shovels and wagons	Gutters of all streets	Main streets
Elkhart	Snow only—all	1 mile	Teams, grader and wagons	300,000 sq. yd.	300,000 sq. yd.
Gary	.....	No stated amount	Motor snow plows	20 business blocks	None
Hartford City	Snow only—all	None	Snow plows	None	Yes
Indianapolis	None	371 miles	Snow plows and large scoops, drawn by 5-ton trucks; scrape to manholes	All	Street car lines
Lafayette	None	17 miles	Hand shovels, trucks and wagons	17 miles	None
La Porte	All	None	.....	All	None
Lebanon	Snow only—all	4 mile	Dump wagons	.....	17,600 sq. yd.
Shelbyville	None	2½ miles occasionally	Hand shovels and wagons	None	25 miles
South Bend	Snow only	Business district	Grader and trucks	Business district	.....
Terre Haute	None	3 miles	Grader and shovels	3 miles[b]	None
Wabash	None	0.8 mile	Snow plows, graders, wagons	11 miles	None
Iowa:					
Cedar Rapids	5	1 mile	Trucks, wagons, shovels	4 miles	.....
Charles City	None	None	.....	36,520 sq. yd	88,273 sq. yd (once a week)
Des Moines	None	Business district	Hand removal	All	None
Keokuk	None	None	.....	70,500 sq yd.	None
Ottumwa	Very few	3 to 5 blocks	Trucks	.....	None
Kansas:					
Iola	Only snow	Around public sqs.	Shovels and brooms	Along curbs	All pavements
Pratt	None	None	.....	4 blocks	None
Kentucky:					
Fort Thomas	None	.....	Trucks	.....	.....
Louisville	None	2 miles	Snow plow and wagons	Gran, brick & asphalt	.....
Mayfield	None	1 mile	Hand shovels	1 mile	None
Maine:					
Bangor	50	1 mile	Teams	1½ miles	¾ mile
Rockland	None	1½ miles	Horses and sleds	33,700 sq. yd.	None
Massachusetts:					
Adams	None	3 miles	Men and teams	1 mile	4 miles
Brockton	None	3 miles	Scraper and hand shovel	2,300 sq. yd.	Scattered
Cambridge	Public property	Very few	Horses and teams	.....	All
Concord	Small	Ap. 40 miles	Holt 10-ton tractor, Sargent plow, 3 truck plows	Very small	None
Gardner	None	50 miles plowed	10-ton Holt tractor	60,000 sq. yd.	Some
Haverhill	None	10 miles	Trucks, teams and shovellers	10 miles	.....
Hudson	Snow, all	All streets	Truck plow	½ mile, 28 ft. wide	Once in 2 weeks

STREET CLEANING STATISTICS—II

City	Area of Streets on Which City Uses—Pick-up Sweepers	Flushing Machines	Hand Flushing by Hose	Machine Sweepers in Business Dist.	Day or Night Cleaning by—Flushing	Average Area Per Man Covered by White Wing or Patrol
Alabama:						
Florence	None	None	None	.....	.....	.....
Gadsden	None	202,000 sq. yds.	None	.....	Night	.....
Talladega	None	None	None	.....	.....	.....
Arizona:						
Tucson	None	None	None	.....	.....	30,000 sq. yds.
Arkansas:						
Fayetteville	.....	.....	10,000 sq. yds.	.....	Night	8,000 sq. yds.
California:						
Monterey	None	None	None	.....	.....	10,000 sq. ft.
Napa	None	50,000 sq. yd.	None	.....	Day	21,000 sq. yd.
Redlands	3 miles	2 miles	.....	.....	Night	2 miles
Santa Ana	.....	None	.....	Night	.....	18,000 sq. yd.
South Pasadena	None	None	None	.....	.....	1 mile
Colorado:						
Denver	72 mi. paved sts.	All paved streets	None	Night	Both	About 10 blocks
Connecticut:						
Hartford	None	563,194 sq. yd	None	None	Night	10,000 sq. yd.
New Britain	None	Being tried on pav.	None	.....	.....	5,000 to 30,000[a]
New Haven	None	60 miles	None	.....	Day	20,000 yds.
New London	None	None	None	.....	.....	72,000 sq. yds.
Willimantic	None	None	2 miles	.....	Night	2 miles
Florida:						
Key West	None	None	Paved streets when necessary	None	None	None
St. Petersburg	None	None	None	.....	.....	5 blocks
Georgia:						
La Grange	None	150,000 sq. yd.	None	.....	Night	.....
Idaho:						
Lewiston	3 miles	3½ miles	None	.....	Night	1 mile
Twin Falls	None	17 mi.—all pav.	.....	.....	Busi., night; residence, day	14 blocks
Illinois:						
Canton	None	None	None	Night	.....	15,000 sq. yd.
Centralia	All	None	None	Night	.....	.....
Freeport	None	None	Business dist.	.....	Night	3 men
Kankakee	15 miles	.....	.....	Early morning	.....	12 blocks
Oak Park	None	None	None	.....	.....	None
Quincy	None	5 miles	None	No	Day	5 miles
Sterling	.....	.....	.....	.....	.....	.....
Winnetka	Business district	None	None	.....	.....	.....
Indiana:						
Bedford	None	None	10 blocks	.....	Night	10 blocks
Brazil	.....	.....	1 mile	Night	Night	.....
Elkhart	None	None	None	Night	.....	None
Gary	.....	.....	None	.....	.....	20 blocks
Hartford City	None	None	None	Night	.....	None
Indianapolis	None	All	Downtown car line intersections	.....	Two 9-hour shifts	22½ squares
Lafayette	None	None	None	.....	.....	1 mile
La Porte	None	None	None	.....	.....	15,000 sq. yd.
Lebanon	None	None	None	Early morning	.....	7,000 sq. yd.
Shelbyville	None	None	None	Night	.....	.....
South Bend	Balance of paved streets	All	None	Night	Night	5 to 10 blocks
Terre Haute	None	None	None	.....	.....	¾ mile
Wabash	None	None	Business dist.—3 times summer	.....	.....	2 miles
Iowa:						
Cedar Rapids	.....	71 miles	.....	.....	Both	9,000 sq. yd.
Charles City	None	None	None	.....	.....	12,170 sq. yd.
Des Moines	None	Business district	None	.....	Both	.....
Keokuk	None	70,500 sq. yd.	None	.....	Night	23,500 sq. yd.
Ottumwa	None	Busi. dist. mostly	None	.....	Day	6 to 7 blks. gutters
Kansas:						
Iola	None	.....	.....	Day	.....	18 or 20 blocks
Pratt	None	None	None	.....	.....	.....
Kentucky:						
Fort Thomas	.....	.....	.....	.....	.....	.....
Louisville	.....	All granite, brick and asphalt	None	Night	Night	2 miles
Mayfield	None	.....	Occasionally	.....	Night	mile brick street
Maine:						
Bangor	None	1 mile	None	Night	.....	.....
Rockland	None	None	None	No	No	11,230 sq. yd.
Massachusetts:						
Adams	.....	1 mile	.....	Early morning	Night	½ mile
Brockton	None	32,000 sq. yd.	None	.....	Night	2,000 sq. yd.
Cambridge	All	None	None	Night	.....	½ mile
Concord	None	None	None	None	None	None
Gardner	.....	None	Some	.....	.....	15,000 sq. yd.
Haverhill	10 miles	Sprinkling only	.....	Night	.....	115,000 sq. ft.
Hudson	.....	None	Sometimes	Day	.....	None

Sewer Construction Devices in Worcester

In reply to a question concerning the use of labor-saving appliances in Worcester, David M. Earle, the city engineer, informs us that an Erie steam shovel is used in excavating sewer trenches and that a fair day's work of eight hours is the excavation of about 175 cubic yards. The crew consists of an engineer, a fireman and two helpers, and the total cost of operation is figured to be about $43 for eight hours' work, giving a little less than 25c a cubic yard for the cost of excavation.

STREET CLEANING STATISTICS—II

City	What percentage of sidewalks does city clean?	Snow Removed by City: From how many miles of streets?	Snow Removed by City: Methods and appliances used	Area of Streets on Which City Uses: Hand Brooms	Area of Streets on Which City Uses: Machine Brooms
Massachusetts (Continued):					
Natick	None	2 miles	2 or 3 teams, 1 Fordson, 2 trucks, a V plow	Gutters and pick-up, 50,000 sq. yd.	.....
Northbridge	90	2 miles	Tractor, snow plow trucks	2 miles	.....
Orange	None	Principal streets	Tractor, snow plow, auto truck	Small part	None
Reading	None	54 miles	Road and tractor plows on trucks	Gutters only	None
Michigan:					
Alma	Residence	7 miles	Graders, trucks, wagons	None	.....
Ann Arbor	All after snow storm	2 or 3 miles	Wehr grader and trucks	20 miles	.....
Flint	All	3 miles	Snow plow on tractor and trucks	90 miles	.....
Grand Rapids	None	6.3 miles	Graders, teams & trucks	3,007,555 sq. yd.	None
Highland Park	All	42 miles	Scraper and hand shovel	5 miles	42 miles
Holland	None	1 mile	Teams and sleighs	Gutters only	.....
Manistique	All, snow only	None	Horse-drawn snow plow	1 mile	.....
Muskegon	None	8 miles	Trucks and shovels	50 miles	None
Pontiac	All, snow only	4 miles	Truck and plow, tractors, hand shovel	All gutters	None
Port Huron	City property	1 mile	Shovels, wagons	250,000 sq. ft.	None
Minnesota:					
Chisholm	All	23 miles	2 trucks with plows, 2 horse plows	Gutters	None
Cloquet	All	None	.....	On pavements	None
Hibbing	All	.....	Trucks and teams	7 miles	.....
Rochester	All, snow only	.....	Home made and Baker	None	None
St. Paul	Snow from some	Downtown and main streets	Plows with Mack truck, horse drawn plows and dump wagons	90 miles	None
Willmar	None	None	.....	Paving only	Paving only
Missouri:					
Jefferson City	None	None	.....	20,000 sq. yd.	7,500 sq. yd.
Kansas City	None	603 miles	Shovel, auto carts, also flush with hose	All	None
Marshall	None	35	None	8 blocks	None
St. Charles	None	Only crosswalks	Shovels	2 miles	None
St. Joseph	None	3 miles	Trucks and wagons	3 miles	None
Sedalia	None	None	.....	None	40 blocks
Montana:					
Bozeman	1[g]	Occasionally ¼ mi.	Team, grader and sled	225,000 sq. ft.	None
Lewistown	None	None	.....	None	None
Livingston	All of snow	None	Fordson tractor and snow plow	Along gutters	None
Nebraska:					
Lincoln	None	25 miles	Grader and buckboards	.....	None
Norfolk	25	5 to 6 miles	Blade grader, wagons, shovels	30,000 sq. yd.	300,000 yd.
New Hampshire:					
Nashua	All, snow only	5 miles	Men and trucks, tractor and plow	10 miles dirt streets	None
New Jersey:					
Asbury Park	100	1 mile	Shovels and carts	3 miles	None
Irvington	None	30 miles	Trucks and plows	None	.....
Salem	None	2½ miles	Scraper	2½ miles	2½ miles
New Mexico:					
Albuquerque	None	None	.....	None	All
New York:					
Endicott	None	1 mi., plow 9 mi.	Plow on truck	Along gutters	None
Gloversville	Snow only[d]	Approx. 45 miles	Tractor and trucks with plows	None	None
Johnson City	10[d]	1 mile	Truck, shovels	3 miles	.....
Kingston	None	40 or 50 miles	Tractor with plow, shovels and carts	50% of sts. cleaned	None
Norwich	1%	½ mile	Scraper and horse-drawn vehicles	1 mile	6 to 7 miles
Tonawanda	20	None	.....	½ miles	11 miles
North Carolina:					
Burlington	None	5 miles	Shovel and snow plow	Corners and intersections	.....
Gastonia	All	17 miles	Tractor, plow, shovel, horse drag	.....	All
Thomasville	None	None	.....	Approx. 10%	90%
North Dakota:					
Fargo	Snow only[g]	10 miles	Tractor and plow	10%	.....
Ohio:					
Akron	Small	2,693,271 sq. yd.	Plows on trucks and tractors	Gang work 25.1%, station 10.2%	43.7%
Chillicothe	None	None	.....	None	16 miles
Cincinnati	None	50 miles	Snow plows, tractors, wagons, hand labor	254,500,000 sq. yd. of cleaning done	None
Circleville	None	None	.....	5 miles	.....
Dayton	City property	Business section	Baker snow plow	720,031 great squares	None
Delaware	None	None	.....	31,680 sq. yd.[h]	None
East Youngstown	10	2 miles	.....	All	None
Findlay	Snow only	Business district	Wagons and trucks	30 blocks	None
Fremont	Crossings	Sidewalks	Plow and shovels	All	.....
Lima	None	Business crossings only	Trucks	Business district	.....
Mansfield	None	2 miles	City loads, St. Ry. hauls	290,000 sq. yd.	475,000 sq. yd.
Middletown	None	3 miles when over 8-10 inches	Street grader, trucks and wagons	6 ft. from curb	7 ft. wide
Urbana	None	¾ mile	Snow plows and wagons	Busi. section gutters	None
Van Wert	All snow and ice	2 mi. crosswalks	Shovels and snow plows	.....	None
Zanesville	None	1 mile	Teams and laborers	20,000 sq. yd.	None

STREET CLEANING STATISTICS—II

City	Area of Streets on Which City Uses—Pick-up Sweepers	Area of Streets on Which City Uses—Flushing Machines	Area of Streets on Which City Uses—Hand Flushing by Hose	Day or Night Cleaning by—Machine Sweepers in Business Dist.	Day or Night Cleaning by—Flushing	Average Per Man Covered by White Wing or Patrol
Massachusetts—(Continued):						
Natick	.....	.....	½ mile	Night	Early morning	50,000 sq. yd.
Northbridge	.....	None	.....	.....	.....	.....
Orange	None	None	None	.....	.....	None
Reading	None	None	None	.....	.....	None
Michigan:						
Alma	None	100%	None	Day	Day	None
Ann Arbor	21 miles	None	None	Night	.....	3½ miles
Flint	Just started	90 miles	.....	Night	3 a.m. to 2 p.m.	15,000 yds. gutters only
Grand Rapids	5,991,491 sq. yd.	In connection with hand brooms	None	.....	Night	16,395 sq. yd.
Highland Park	42 miles	None	None	Night	.....	10 miles
Holland	.....	All pavements	None	.....	Night	25,000-35,000 sq. yd.
Manistique	.....	.....	None	None	.....	.....
Muskegon	None	None	None	.....	.....	.....
Pontiac	None	28 miles	None	.....	Both	15,000 sq. yd.
Port Huron	None	140,000 sq. yd.	None	.....	Night	.....
Minnesota:						
Chisholm	None	101,000 sq. yd.	None	.....	Both	.....
Cloquet	None	All pavements	None	.....	Day	20,000 sq. yd.
Hibbing	.....	7 miles	.....	.....	Both	.....
Rochester	None	19.2 miles	None	.....	Both	.....
St. Paul	None	All paved streets	None	.....	Night	4 blocks
Willmar	None	None	None	Night	.....	300,000 sq. ft.
Missouri:						
Jefferson City	.....	.....	.....	Night	.....	.....
Kansas City	None	None	None	.....	.....	.....
Marshall	None	None	None	.....	.....	8 blocks
St. Charles	None	2 miles	None	.....	Both	None
St. Joseph	None	120 miles	None	.....	.....	6 blocks
Sedalia	None	None	None	Night	.....	None
Montana:						
Bozeman	None	264,000 sq. yd.	Ap. 200,000 sq. ft. occasionally	.....	Early morning	225,000 sq. ft.
Lewistown	None	144,000 sq. yd.	None	.....	Residence, day; busi., night	None
Livingston	None	None	None	.....	.....	.....
Nebraska:						
Lincoln	None	65 or 75 blocks	None	Night	Night	10 blocks
Norfolk	None	300,000 yd.	None	Night	Both	10,000 yd.
New Hampshire:						
Nashua	25 miles	None	None	Night	.....	2,500 sq. yd.
New Jersey:						
Asbury Park	None	None	None	.....	.....	⅜ mile each
Irvington	All	None	None	Night	.....	.....
Salem	None	None	None	Night	.....	1¼ miles
New Mexico:						
Albuquerque	20 miles	20 miles	None	Night	Night	.....
New York:						
Endicott	None	All	None	.....	Day	.....
Gloversville	None	All paved streets	None	.....	Both	.....
Johnson City	.....	3 miles	.....	.....	Both	½ mile
Kingston	.....	All paved streets	None	.....	Night	About 1 mile
Norwich	None	None	None	.....	.....	½ mile
Tonawanda	11 miles	.....	.....	Day	.....	½ mile
North Carolina:						
Burlington	8 miles	None	None	Night	.....	.....
Gastonia	.....	.....	Main street	Night	Night	.....
Thomasville	None	None	None	Night	.....	.....
North Dakota:						
Fargo	.....	All paved streets	Alleys	.....	Night	10 blocks
Ohio:						
Akron	Included in "Machine brooms"	21%	None	Night	Night	.....
Chillicothe	16 miles	Discontinued	None	Night	.....	.....
Cincinnati	5,363,000 sq. yd. of cleaning	205,436,000 sq. yd. of cleaning	None	Night	Night	15,000, sq. yd.
Circleville	.....	2 miles	.....	Day	Day	5 miles
Dayton	None	456,700 sq. yd.	None	None	Busi. section, night; res., day	391 great squares
Delaware	None	158,400 sq. yd.	None	.....	Day	.....
East Youngstown	None	2 miles	500 feet	.....	Day	7 miles
Findlay	None	None	None	.....	.....	5 blks. & intersec.
Fremont	.....	.....	4 blocks	.....	Night	.....
Lima	60 miles	60 miles	None	Night	Busi. district. night; res., day	3 miles
Mansfield	.....	.....	.....	.....	.....	21,000 sq. yd.
Middletown	None	None	None	Busi., from 4:30 A. M.; res., day	.....	.....
Urbana	None	5 miles	None	.....	Busi. district. night; res., day	Gutters on 5 mi. of streets weekly
Van Wert	None	None	None	.....	.....	.....
Zanesville	None	30,000 sq. yd.	None	.....	Night	.....

Tree Planting on Highways

Many advocates of planting trees on highways have presented their arguments and with few dissenting from them, but recently Alexander Muir, superintendent of the Maintenance Department of the New Jersey State Highway Commission, in a discussion of the matter pointed out that the drains used under highways, an essential to maintaining proper conditions in many localities, are necessarily laid with open joints and that these joints offer entrance to the roots of trees planted nearby. He cited one stretch of road which "blew up" where, upon investigation, it was found that the drains were packed tight with tree roots which thus entirely prevented their operation.

STREET CLEANING STATISTICS—II

City	What percentage of sidewalks does city clean?	Snow Removed by City: From how many miles of streets?	Snow Removed by City: Methods and appliances used	Area of Streets on Which City Uses: Hand Brooms	Area of Streets on Which City Uses: Machine Brooms
Oklahoma:					
Blackwell	None	3 miles	Grader and drags	All	.....
Chickasha	None	None	.....	37 blocks, 400x80	None
Enid	None	Sometimes	Shovels	40 miles	None
Oregon:					
Astoria	None	.....	.....	Gutters after flusher	None
The Dalles	None	1½ miles	Trucks or scrapers	18,000 lin. ft.	None
Pennsylvania:					
Ashland	None	None	.....	Owners sweep up, truck gathers	.....
Butler	Street intersect.	1½ miles	Hand work & rd. machine	None	All
Carbondale	10	50 miles	Hand methods	All	None
Clairton	Some occasionally	Rarely	Hand scoops	All	None
Clearfield	None	1 mile	Hand shovels & trucks	3,600 ft. x 30 ft.	None
Dormont	None	1 mile	Shovel, truck	.....	.....
Forest City	Around boro bldgs.	5 blocks	Teams and sleighs	5 blocks	None
Freeland	None	0.75 mile	Trolley cars and dump wagons	2½ mi. paved streets 51 miles	None
Lancaster	None	6 to 10 miles	Snow plows and trucks		None
Meadville	60; snow	1 mile	Hand shovel and gutter plow	2½ miles	20½ miles
Middletown	None	None	.....	Outside edges, cleared area	.....
Munhall	None	None	Hand brooms and horse-drawn broom	16 miles	1 mile
Norristown	None	Only drifts	Hand shoveling & horse drawn plows assisted by street railway plows	25,000 sq. yd.	.....
Philadelphia	Debris from 100	12 miles	Machine plows, hand load and snow loaders	9,000,000 sq. yd.	16,800,000 sq. yd
Rankin	None	1 mile	Shovels and wagons	All paved streets	None
Steelton	None	1 mile	Men and trucks	All paved streets	None
Swoyerville	None	1 mi. street cross.	Shovels	None	None
West Pittston	Crosswalks	None	Hand shovels	4 miles	.....
Woodlawn	None	1 mile	Hand shovels & trucks	52,544 sq. yd.	None
Rhode Island					
Pawtucket	None	2 miles	Shovels, trucks, tip-carts	16.5 mi. or 2,600,000 sq. ft.	None
Woonsocket	None	Where st. car trk.	Cart or trucks	.....	.....
South Carolina					
Chester	None	None	.....	70,000 sq. yd.	None
Orangeburg	All	None	.....	26,000 sq. yd.	160,000 sq. yds.
South Dakota					
Lead	40	None	.....	50% of paved streets	None
Rapid City	None	None	.....	.....	.....
Tennessee					
Jackson	None	None	.....	150,000 sq. yd.	None
Kingsport	None	.....	.....	.....	None
Murfreesboro	None	None	.....	5,000 sq. yd.	45,000 sq. yds.
Texas					
Amarillo	None	.....	.....	All	None
Burkburnett	None	.....	.....	3 blocks	None
Childress	25	.....	.....	All	.....
Del Rio	None	.....	.....	1 mi. 30 ft. wide	None
Eastland	None	.....	.....	Business district	None
San Angelo	None	.....	.....	None	7 blocks
Vermont					
Brattleboro	Snow only, all	2,000 ft.	Teams and sleighs	2,000 ft.	None
Rutland	All	½ mile	Trucks, tractors & plows	½ mile	.....
Virginia					
Danville	City prop. only	2 miles	Hose	.....	.....
Fredericksburg	None	.....	.....	136,000 sq. yd.	20,000 sq. yds.
Harrisonburg	.....	1 mile	Trucks	150,000 sq. ft.	.....
Newport News	None	34 miles	Adams grader, wagons, carts	47,000 yds.	.....
Richmond	None	50 miles	Road machines, trucks and carts[c]	.....	1,706,794 sq. yds.
Staunton	None	½ mile	Road machine, wagons	21 blocks	21 blocks
Washington					
Aberdeen	None	.....	Shovels and hand-made wooden snow plow	15 blocks	20 blocks
Walla Walla	None	Pav. sts., 30 mi.	Baker snow plow	None	None
West Virginia					
Clarksburg	None	2 miles	Road machines & trucks	14,000 sq yd.	None
Fairmont	None	Crosswalk & gutters in bus. dist.	Truck and shovelers	With flusher only	None
Wisconsin					
Baraboo	Small[d]	None	.....	None	All
Beaver Dam	None	3 blocks	Scraper	None	None
Kaukauna	All	5 blocks	Wagons	14 blocks	.....
Kenosha	5	½ mile	Hand shovels and motor trucks	30,000 sq. yd.	None
Marinette	None	2 miles	Wagons and trucks	64,120 sq. yd.	None
Wisconsin Rapids	Snow only	5 miles	Graders and carts	None	None

[a]—Depending on traffic and kind of pavement [b]—Other streets cleaned by hand scrapers made from old saws. [c]—Hauled from two miles of streets in trucks and carts, loaded by hand and steam shovels; on 48 miles, pushed to gutter with road machines pulled by Holt and Fordson tractors. [d]—When property owners fail to do so. [e]—Total area of improved pavement daily, 563,194 sq. yds. of macadam once a month. [f]—Use plows on 50 to 90 miles [g]—Charged against property. [h]—Strip about 3 ft. wide along gutters.

In addition to this, he suggested careful consideration of the fact that tree roots, if growing under the pavement, are able to lift the edge of the pavement, no matter how thick and strong, and that therefore the trees should be kept a sufficient distance away from the pavement itself.

At a general conference of asphalt producers, highway engineers and officials, the asphalt

STREET CLEANING STATISTICS—II

City	Area of Streets on Which City Uses: Pick-up Sweepers	Flushing Machines	Hand Flushing by Hose	Day or Night Cleaning by: Machine Sweepers in Business Dist.	Flushing	Average Per Man Covered by White Wing or Patrol
Oklahoma:						
Blackwell	.....	None	None	.....	.....	.....
Chickasha	None	74 blocks, 400x80	None	.....	Night	16 blocks, gutters only
Enid	None	None	Business dist.	Day	.....	.....
Oregon:						
Astoria	None	15 miles	None	.....	4 to 9 A. M.	None
The Dalles	None	30,000 lin. ft.	.....	.....	Early morning	.....
Pennsylvania:						
Ashland	.....	.....	.....	.....	.....	.....
Butler	All	None	None	Night	.....	3 miles
Carbondale	None	None	20,000 sq. yd.	.....	Day	120,000 yd.
Clairton	None	None	None regularly	.....	.....	¾ mile
Clearfield	None	None	3,600x30 ft.	.....	Day	.....
Dormont	20 mi., 24 ft. wide	None	2 mi., 24 ft. wide	Night	.....	.....
Forest City	None	5 blocks	5 blocks	.....	Night	.....
Freeland	None	None	2½ miles	.....	Day	2½ miles
Lancaster	None	51 miles	None	.....	Both	16 to 20 blocks
Meadville	20½ miles	None	2½ miles	Night and early morning	Night	2½ miles
Middletown	.....	.....	.....	Day	.....	None
Munhall	None	None	.....	Day	.....	
Norristown	Discontinued	.....	.....	Day	Day	.....
Philadelphia	500,000 sq. yd.	8,000,000 sq. yds.	260,000 sq. yd.	Both	Both	20,000 sq. yd.
Rankin	None	None	None	.....	.....	.....
Steelton	None	None	None	.....	.....	1 mile
Swoyerville	None	None	None	.....	.....	1 mile
West Pittston	.....	.....	.....	.....	.....	.....
Woodlawn	None	58,500 sq. yds.	None	.....	Night	9,750 sq. yd.; also pick up paper 100 ft. from st.
Rhode Island						
Pawtucket	None	None	None	.....	.....	3.3 mi. or 520,000 sq. ft. per wk.
Woonsocket	3 miles	None	.....	.....	.....	.....
South Carolina						
Chester	None	70,000 sq. yds.	None	.....	Day	.....
Orangeburg	None	26,000 sq. yds.	None	Early morning	Night	.....
South Dakota						
Lead	None	.....	95% of paved st.	.....	Night	9,000 sq. yds.
Rapid City	.....	.....	.....	.....	.....	10,000 sq. yds.
Tennessee						
Jackson	None	150,000 sq. yds.	None	.....	Night	Gutters on 40,000 sq. yds.
Kingsport	.....	Discontinued	.....	.....	.....	.....
Murfreesboro	None	.....	.....	Night	.....	10 to 20 blocks
Texas						
Amarillo	10 blks. square	None	Isolated cases	.....	Night	.....
Burkburnett	None	None	4 or 5 blocks	.....	Night	.....
Childress	.....	.....	All	.....	.....	½ mi. 30 ft. wide
Del Rio	None	None	None	.....	.....	
Eastland	None	None	All pavements	.....	Night	.....
San Angelo	None	None	None	Night	.....	
Vermont						
Brattleboro	None	.....	1,000 feet	.....	Night	1,000 ft.
Rutland	.....	½ mile	.....	.....	Day	.....
Virginia						
Danville	All	.....	.....	Night	.....	.....
Fredericksburg	None	None	None	Night	.....	30,000 sq. yds.
Harrisonburg	.....	.....	.....	.....	.....	.....
Newport News	215,000 sq. yd.	None	None	Night	.....	23,000 sq. yds.
Richmond	829,606 sq. yds.	829,606 sq yds.	None	Night	Both	20,320 sq. yds.
Staunton	.....	.....	.....	Night	.....	.....
Washington						
Aberdeen	None	20 mi. paved sts.	.....	Both	Both	8 blocks
Walla Walla	None	30 miles	None	.....	Night	2½ miles
West Virginia						
Clarksburg	20 miles	None	14,000 sq. yds.	Night	Both	.....
Fairmont	None	All	Special occas.	.....	Day	.....
Wisconsin						
Baraboo	.....	.....	.....	.....	.....	.....
Beaver Dam	20 blocks	20 blocks	None	Night	Night	.....
Kaukauna	.....	.....	.....	.....	.....	.....
Kenosha	709,400 sq. yds.	739,400 sq. yds.	None	Day	Day	7,500 sq. yds.
Marinette	None	None	None	.....	.....	16,412 sq. yds.
Wisconsin Rapids	200,000 sq. yds.	.....	.....	Early morn.	.....	50,000 sq. yds

grades were reduced from 102 to 10, this to become effective January 1st, 1924. Certain definite penetration limits were established for paving asphalt, sheet asphalt and block filler.

Progress has been made also in standardizing roller bearings, spark plugs, tires and storage batteries for automobiles; dimensions of milk bottles; containers for and shades of paints and varnishes; woven wire fencing, and other manufactured materials.

Eliminating Waste

The Chamber of Commerce of the United States reports definite progress in the elimination of waste by standardization in several industries such as automotive accessories, clay products, paints, brick, etc. Of special interest to public works officials are agreements made relative to vitrified clay sewer pipe and asphalt.

A preliminary conference by engineers and manufacturers of clay products resulted in an effort to eliminate many needless sizes and set up dimensional standards for sewer pipe, tile drain, flue linings and wall coping. A survey is being made of the industry to obtain the necessary data and when these have been gathered and tabulated a general meeting of all interests will be called for final action.

Chlorine Production at Independence, Mo.

By A. H. Gallagher*

Use of hypochlorite and liquid chlorine abandoned at this Missouri city for chlorine production at the pumping station, at less cost and with operative advantages and superior results

Following difficulty in obtaining uniform results in treatment of water by use of hypochlorite of lime, the writer some years ago began using liquid chlorine and this seemed for a time to have solved a most serious problem. However, difficulties that all who have used such equipment will appreciate soon developed from impurities in the liquid chlorine, the accumulation of which caused the small orifices to choke. Also the destructive action of chlorine made necessary frequent dismantling and repairing of the machine, which is of such a delicate nature that we have had little success in overhauling it at our plant, while the cost of repairs and replacement of parts when returned to the manufacturer for overhauling was high.

Owing to the effect of temperature upon density, the writer questions whether mechanism could be devised to satisfactorily control dosage when using liquid chlorine, since the rapidity of discharge affects the physical characteristics of the chlorine, at times, to such an extent that refrigeration even takes place. In cold weather it is quite difficult, when high rate of dosage is required, to produce a water of required bacterial standard without producing tastes of chlorine in the water. It is my opinion that the occasional taste or odor of chlorine in water to which the public objects results more from the method of application and control of the gas than from the use of chlorine *per se*.

With our experience in handling chlorine and hypochlorite of lime, the writer was in the right frame of mind to entertain a proposition to install a chlorine producing cell in the pumping station of the Independence Waterworks Company, of which he is superintendent, as an experiment, which proposition was made by the Electrolytic Chlorine Company. Cells manufactured by this company had been operated in flour mills for several years and the only new feature was the method of introducing chlorine gas into the water. The offer was accepted and one of these cells was installed in this plant about two years ago and has operated since with very satisfactory results. The control of the dosage is accomplished by controlling the amount of chlorine gas produced, this being proportional to the number of amperes of current flowing through the brine solution, and the proper rate of dosing is determined by the direct proportion between amperes used and rate of pumping water.

In the development of such a cell the problem is to design one which produces as nearly as possible the theoretical ampere efficiency, which is dependent entirely upon the prevention of secondary reactions within the cell. In the cell installed in this plant graphite pins are used as anodes, while an iron wire screen that forms the bottom of the cell is the cathode, on which rests an asbestos paper diaphragm. The cell is filled with brine and when the current passes through this, chlorine gas is liberated and sodium passes to the cathode where it unites with water to form caustic soda. Being of higher specific gravity than the brine, most of the caustic soda remains below the diaphragm, outside the cell; some of it returns to the cell because of capillary action, but the amount so returning is very small and goes into solution with the brine, while that which does not so repass is carried out through the overflow duct. It is desirable to maintain a uniform supply of brine in the cell to replace that which is decomposed by the electric current, but the brine flow may be interrupted for a time without detriment since the brine above the zone of action keeps up the concentration. The brine is made by leeching, the water seeping through a body of salt, and it is impossible for brine to enter the cell that is not a saturated solution.

Temperature has no effect upon the operation so long as it remains above the freezing point. However, a cell starting cold has a higher resistance which requires increased voltage to produce the flow of the required amperage. There is a slight disintegration of the anode, but the action is uniform throughout the period of use and does not affect the uniform operation of the cell. Apparently the anodes will require renewal about every four years, the cost of this being about $20. During two years of manufacturing our own chlorine we have found the process convenient and producing a uniform supply, positively known, accurately regulated and reliably maintained.

The water supply is taken from the Missouri river about 1½ miles below the sewer outlets of the two Kansas City's, whose combined population is upward of 500,000, and for this reason the production of a potable water is increasingly difficult. Prior to manufacturing our own liquid chlorine, the bacteriological results obtained were erratic, but during the past two years the bacteriological count has been uniformly lower than that of plants obtaining their supply further upstream and at no time has the treated water been criticized by the State Sanitary Department on account of bacterial pollution. We believe that this improvement in result is due partially to the fact that the chlorine gas is mixed with many times its volume of air before

*Supt., Independence Waterworks Company, Independence, Mo.

it is introduced into the water. This secures a greater distribution of the chlorine in the water. Its action upon oxidizable matter when so diluted will be slower but sufficiently active to effect more complete sterilization of living organisms as a result of the greater distribution.

Figures of continuous operation for 222 days show the cost of operation to have been: For salt, $51.60; for power, $106.16; diaphragm renewals, $3.60; a total of $161.36. The total amount of chlorine produced was 3,330 pounds, making the cost 4.81c per pound. The salt consumed was equivalent to 2½ pounds per pound of chlorine produced, and the power consumed to 2 kwh., which cost 1.7c per kwh. Up to date nothing has been spent in maintenance of the cell and as a new cell could be installed at a cost of $35 or less, the cost of upkeep is merely nominal. The lessened cost of sterilizing the supply, however, we consider of secondary importance to the operative advantages and superior results obtained.

An average of sixty consecutive analyses of the water gives the following results:

Average turbidity of settled water, 45.

Gas Formers—Samples collected in town: 322 ten c.c. tubes examined; negative, 318; positive, 4; percentage reduction, 98.75.

Samples collected at pumping station: 321 ten c.c. tubes examined; negative, 312; positive, 9; percentage reduction, 97.2.

The settled unchlorinated water always showed presence of gas formers, in one-half c.c.'s.

Plate Counts: Settled water, daily average, 979 per c.c.

Samples collected at station, after chlorination: Average daily count, 56; percentage reduction, 94.28.

Samples collected in town, average daily count: 70 per c.c.; percentage reduction, 92.85.

Average daily dosage, 1.1 parts per million.

The causes of the presence of gas-forming bacteria in the finished water were satisfactorily established, and in each instance it was noted that they were not traceable to delinquencies on the part of the chlorinator.

The suggestion that chlorine gas be manufactured in the pumping station as needed, and applied to the water as produced, is apt to impress the water works management at first thought as too technical, difficult and troublesome an undertaking for the ordinary operating force to handle; but, this notion is quickly dispelled under actual operation. The production and dosage of chlorine gas by this method is in reality a very simple operation, requiring but little attention, and any one capable of operating the usual pumping station equipment of a small plant can readily install and operate the cell.

Bituminous Pavement in Pennsylvania

In an interview a few weeks ago, Paul D. Wright, secretary of highways of Pennsylvania, stated that the impression in some quarters that the state would discontinue building concrete roads was a mistaken one, but that it was the "policy of the department to construct pavements suited to the present and estimated future traffic requirements. Its specifications allow bids either on all concrete or on concrete base with asphalt top pavement. The department believes that it is unbusinesslike and unwise to construct a costly pavement where for twenty or thirty years to come traffic would be equally well served by a less costly pavement, such as a bituminous surface pavement which can be put down and maintained for very much less annual cost to the taxpayer. Most of the criticism of our policy in a recent issue of a Philadelphia newspaper is a result of the bituminous resurfacing of stone roads, an operation which gives a serviceable pavement for fifteen to twenty years for a character of traffic which does not justify a more costly pavement."

He stated that resurfacing the present macadam roads with bituminous surface is "justified by present and estimated future light traffic requirements, and will enable the state to improve more miles of roads and lift more people out of the mud than if all the money were concentrated in the construction of costly highways."

Figuring the annual cost of bituminous surfaced macadam road, Mr. Wright gives the original cost per mile as $21,150; yearly sinking fund charge on a basis of fifteen years of life, $1,137; average yearly interest charge, $1,058; yearly maintenance cost, $500. This gives a total of $2,695.

Refuse Collection in England

An English engineering paper gives interesting information concerning the use of motor vehicles by English cities for the collection of house refuse. In Birmingham, which was one of the earliest to adopt electric vehicles for this purpose, such vehicles are considered more economical than horse-drawn vehicles beyond a radius of 1¼ miles from the point of disposal, according to the statement of Mr. Cook, one of the officials of the Cleansing Service of that city. Mr. Cook believes that even within that radius "the use of larger capacity vehicles, combined with electric auto-trailers may outclass the horse."

In another city, Durham, gasoline motors have been employed, a saving of about $3,000 having been effected last year by changing to these from horses, while the complaints have dropped from 300 or 400 a month to not more than 3, indicating much greater efficiency with the rapidly moving motor vehicles. This English paper points with pride to the fact that Ford trucks and an English truck known as the "Albion" having both been tried in this work, the cost of collection by the former figures out one shilling and five-and-a-half pence more per ton than by the Albion. Apparently, however, the Ford car has obtained much the same standing there that it has in this country, one English manufacturer having placed on the market a low-hung trailer to be hauled by a Fordson tractor, the trailer being hauled by horses during collection and a number being combined into a train to be hauled by the tractor to the dump.

Recent Legal Decisions

FAILURE TO COMPLETE STREET IMPROVEMENT IN TIME

A street improvement ordinance adopted under the San Francisco Charter, provided that the contractor's failure to complete the contract within the time fixed or within the extension therein provided would render the contract void, and that no assessment should be made for the work done under the contract. The California Supreme Court holds, Flinn v. Shafter Realty Co., 112 Pac. 194, that a failure of the board of supervisors to grant an extension of time within the original period is not a mere error or informality which can be cured by failure of the property owners to appeal or by a subsequent extension of the time, and if the work has not been done or extension granted the assessment is invalid.

LIABILITY FOR DAMAGE FROM INCINERATOR

The North Carolina Supreme Court holds, Dayton v. City of Asheville, 115 S. E. 827, that where a city has a right to erect an incinerator and to maintain it for the benefit of the public, in the exercise of its governmental duty, it will not be held civilly liable to individuals for injuries resulting therefrom, when properly built and operated, upon the theory of a trespass, in the absence of some legislative authority or a statute conferring such right of action. But this does not militate against the right of recovery for a taking or appropriation, in whole or in part, of property for a public use without due compensation.

This distinction may become important upon the question of whether the statute of limitations applies in an action against the city. For an irregular, intermittent and variable trespass, if the city should be liable for such a tort at all, the plaintiffs, claiming damage to their property from smoke, ashes, etc., settling thereon, and the pollution of the atmosphere, would be entitled, under the state tatute of limitations, to recover all damages accruing within the three years next immediately preceding the commencement of the action, provided proper claim had been made therefor, as required by the city charter. But under the theory of taking by eminent domain, where the injury is permanent, constant, and continuing, the cause of action accrues and limitations begin to run from the time of the first substantial injury.

CONTRACT TIME FOR COMPLETING PAVING DOES NOT INCLUDE SUNDAY WHERE SUCH WORK IS PROHIBITED

A paving contract to be performed in St. Joseph, Missouri, provided that the job be completed within 130 days from the date of its award, "the time of beginning, rate of progress and time of completion being essential conditions of this contract." It is held, Van Haaften v. Clayton (Mo. App.) 246 S. W. 964, that the time within which the work was to be completed did not include Sundays, since, under the Missouri statute (Rev. St. 1919, Sec. 3596) the contractor could not legally be required to pursue the labor of constructing the pavement on Sunday.

CITY CANNOT BIND ITSELF TO BE SUED OUTSIDE OF ITS COUNTY

The weight of authority holds that any action against a municipal corporation is of an inherently local nature and must be brought in the county in which the municipality is situated. The view expressed by the courts is that it is of the greatest importance to the welfare of such public bodies, as well as of the citizens of municipalities, that their officers be not subjected to being called away from their duties to attend the trial of cases at distant points. Therefore, the Texas Court of Civil Appeals holds, City of Corpus Christi v. Oriental Oil Co., 246 S. W. 718, that a municipal corporation cannot be bound by a contract limiting or changing the venue of a cause of action against a municipality for goods purchased so as to render a suit maintainable in a venue beyond that of its domicile.

ROAD CONTRACTING ENGINEERS' FEES

The Arkansas Supreme Court holds, Carter v. Bartholomew, Road Improvement Dist., 246 S. W. 487, that a road contracting engineer's fee of $50 a day is excessive. An engineering firm contracted along with a state highway engineer, to perform services for a road improvement district. The latter, by virtue of his holding office, was held disqualified from recovery for his services. But the engineering firm was not disqualified, because of their contracting along with the highway engineer, from recovering for their services, there being no collusion between the firm and the highway engineer, who was not a partner of the firm.

CITY'S POWERS OF CONDEMNATION AND RATE FIXING NOT REDELEGABLE

The Missouri Supreme Court holds, State v. Maitland, 246 S. W. 267, that the grant of power to condemn property is a grant or delegation of power by the state to the city, and not to any board or commission of the city, and it has serious doubt of the right of a city by either charter or ordinance to redelegate this power to a water commission, that is, the power to determine upon and select the property to be condemned. A city's delegated power to fix rates to water consumers is a legislative function, which may not be redelegated by the city to a water commission.

CONCLUSIVENESS OF ENGINEER'S DECISION

The Oregon Supreme Court holds, Spokane County v. Pacific Bridge Co., 213 Pac. 151, that the rule that where a contract for public work, in express terms, makes the decision of the engineer final as to the performance of the contract, such decision is conclusive on the parties, does not apply where the contract makes the decision of the engineer who supervised the work final as to the true construction and meaning of the profiles, maps, plans and specifications, but does not make his decisions in respect to performance of the work final and conclusive upon the parties.

PUBLIC WORKS.
CITY COUNTY STATE
A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"
Vol. 54 November, 1923 No. 11

Paving Streets and Alleys in Dayton

Analysis of unit prices for most common types of street paving shows prices this year five to thirty per cent. higher than last. Specifications and unit prices of each. Plan followed in assessing costs.

By Ivan E. Houk *

More streets and alleys are being paved in Dayton, Ohio, this year than during any year since 1917. Contracts for thirty-four separate jobs, many of which are now completed, have been awarded since January 1. These contracts involve a total area of street paving of 70,185 square yards, at a contract cost of $326,094, of which $30,059 is for the necessary storm sewer work; and 11,905 square yards of reinforced concrete alley paving at a total contract cost of $33,593. In some instances the storm sewers had been installed by the city, by direct employment of labor and direct purchase of supplies and materials, before the paving work was advertised. Legislation is pending for fully that much more work, some of which will be advertised and completed yet this season; and petitions are on file asking for many additional street and alley improvements which we have not, thus far, been able to design owing to the pressure of the construction work. We expect to get these plans worked out during the coming winter so that the legislation can be completed early next year, in time for the work to be done in the summer and fall.

*City Engineer of Dayton, Ohio.

PAVEMENT TYPES

Practically all types of pavements have been laid in Dayton, from cobblestones to granite durax and from sheet asphalt to wood block. However, since there are several brick plants within a comparatively short radius of the city, the brick surfaces naturally predominate. On January 1, 1923, there were 59.34 miles of brick pavements within the corporate limits, 21.66 miles of sheet asphalt, 5.25 miles of wood block, 3.65 miles of concrete, 2.55 miles of granite block and granite durax, 0.37 miles of Medina stone,

LAYING BRICK IN CAR TRACK AND KENTUCKY ROCK ASPHALT ON THE SHOULDERS.
A ¼ inch by 8 inch steel plate is used as a header 18 inches outside the rail.

SAND FOR BRICK PAVEMENT DRYING IN PILES BEFORE BEING MIXED WITH CEMENT FOR CUSHION.

3.24 miles of bituminous macadam, and 2.74 miles of water bound macadam, all figures exclusive of alleys. This season we are laying brick, sheet asphalt, Kentucky rock asphalt, renapped Medina, and concrete; but no wood block, granite block, or durax, since we have no streets under improvement where such types were considered most economical. Practically all of our alley pavements are concrete, although there are a few brick alleys in the downtown section, and a few in the residential districts where hillside brick was laid because of the comparatively steep slopes.

Brick is our general type of construction for car tracks, although we sometimes use durax, renapped Medina, or granite block. When wood block is laid on the shoulders it is either laid up to the rail or up to a suitable header built 18 inches outside the outer rails. On South Main street, which was paved last year, a 6-inch by 18-inch, 1-2-4 concrete header was used. On Brandt street, which has just been completed, and where Kentucky rock asphalt was laid on the shoulders and brick in the car tracks, ¼-inch by 8-inch steel plates were used as a header, placing them 18 inches outside the rails, fastening them to the concrete base by bolts laid horizontally into the concrete, and paving the spaces between the plates and the rails with brick.

PAVEMENT SECTIONS

Our sheet asphalt, Kentucky rock asphalt, wood block, brick, and other types of block pavements, are laid on a 6-inch, 1-3-6 concrete base, using, in the case of the block pavements, either a ½-inch, 1:4 cement mortar cushion, or a 1-inch sand cushion, the former being always used in the wood block construction. A soft filler is used altogether, either a straight pitch or asphalt, or a mastic made by mixing hot pitch or asphalt with equal portions of heated sand. The mastic filler costs slightly more than the straight pitch or asphalt, owing to the extra work involved in heating the sand and mixing the ingredients but is more satisfactory in the case of the stone block pavements where the joints are wide and irregular.

Our specifications call for wood block 3½ inches deep, either 3 or 4 inches wide, and from 6 to 10 inches long with an average length of 8 inches. Two kinds of oil are specified; oil "A," a distillate oil obtained wholly from coal tar, and oil "B," a more volatile oil produced from coal gas or coke oven tar, of which at least 65 per cent must be obtained by distillation. Standard paving brick, 8½ by 3½ by 4 inches in size, are used; either wire cut or repressed and with or without lugs, laying them with a 4-inch depth in most cases. Kentucky rock asphalt surfaces are laid 2 inches deep; and sheet asphalt, 3 inches. While our specifications call for a 1-inch binder and a 2-inch wearing course, in the case of sheet asphalt, we frequently use a 1½-inch binder and a 1½-inch wearing course.

Concrete alley pavements have a uniform thickness of 6 inches, are built with a concrete mix of 1-2-3, and are reinforced with a wire mesh reinforcement having a weight of not less than 28

POURING ASPHALT FILLER ON BRICK PAVEMENT. Littleford Heater, 7-drum capacity, used.

pounds per 100 square feet. The sides of the alleys are made 4 inches higher than the center so that the water will drain down the center. Concrete streets also are built with a 1-2-3 mix, and are reinforced with the same type of mesh used in the alleys. However, the streets, which have been from 25 to 30 feet wide, have a 3-inch crown in the center, so as to throw the water to the curbs. The slabs are made 5 inches thick at the curbs, and 8 inches in the middle of the roadway. At a point one-fourth the distance from the curb to the center, the thickness is 6⅛ inches; and at a point halfway to the center, the thickness is 7 inches. Transverse, built up expansion joints, from ¼ to ⅜ of an inch thick, are placed at 30-foot intervals in the case of alleys, and at 50-foot intervals in the case of streets. Similar expansion joints, ½-inch thick, are placed along both curbs in the case of streets. Screened and washed materials are used in the concrete bases for other types of pavements as well as in the concrete streets and alleys.

We have not thus far changed our slab design as a result of the Bates Road tests, because the conditions on the residence streets where we have been using concrete are different from those existing on rural highways—as regards traffic as well as construction. In the case of city streets the roadways are wider, the edges of the pavements are protected by curbs, the foundations are more uniform and better drained; and, moreover, the traffic does not follow the edges closely as it does on country roads, primarily because of the parking along the curbs. Consequently it does not seem proper to make city pavements thicker at the edges than in the center. We have not as yet used concrete on streets which are subjcted to heavy traffic. If we should in the

Low Unit Prices Bid on Dayton Street Paving Work During 1923

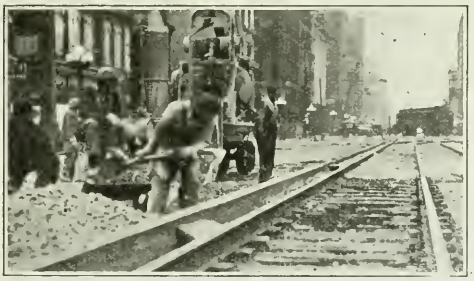
Street	Cu. Yds.	Sq. Yds.	Price per Square Yard Laid: Conc.	Ky. Rock	Sh. Asph.	Brick	Med. Block	Wood Blck.	Gran. Blck	Sewer Cost	Total Cost	Remarks
Brandt	...	8,375	...	...	...	$3.75	...	...	...	...	...	Sand cushion, asphalt filler.
	...	6,755	...	$2.67*	...	4.00*	...	...	...	$237	$27,912	2" Ky. rock on shoulders, brick in car tracks, sand cush., asphalt filler.
	...	6 755	...	2.47	...	4.00	...	...	...	...	...	1½" Ky. rock on shoulders.
Delaware	6,450	4,500	$2.90	...	...	...	...	...	...	5,061	23,357	Standard section.
Dow	4,000	2,300	3.09*	3.41	$3.80	4.10	...	...	...	3,064	13,091	Std. conc. sec., 2" Ky. rock sand cushion, asph. filler for brick.
Fairview	...	5,830	...	...	...	4.10*	...	...	...	946	28,857	Sand cush., asphalt filler.
Grafton	...	4,525	...	...	...	3.89*	...	...	...	1,362	19,390	Sand cush., asphalt filler.
Irwin	...	5,025	...	...	...	3.81*	...	...	...	550	22,148	Sand cush., asphalt filler.
Lefever	4,000	2,000	3.71	3.94*	4.75	...	...	...	...	465	9,794	Std. conc. sec., 2" Ky. rock, 3" Trin.
Main St. Bridge	...	2,650	...	...	...	...	4.94*	...	$7.94	...	14,531	Mortar cush'n, asphalt fill'r
Negley Place	675	1,500	2.30*	...	...	...	...	...	...	155	4,740	Std. sec.
Red Haw Road	2,900	2,250	2.94	3.54*	3.75	...	...	...	...	2,331	13,177	Std. conc. sec., 2" Ky. rock, 3" Trin.
Richmond	7,700	11,550	3.10	3.29	3.45*	4.46	...	$5.00	...	3,527	50,637	Std. conc. sec., 2" Ky. rock, 3" Trin., oil A, mortar cush., asph. filler.
Rosemont	2,100	1,550	2.90*	...	...	...	...	...	...	368	5,823	Std. sec.
Summit	...	10,575	...	...	...	3.99*	...	...	...	7,573	54,019	Sand cush., asphalt filler.
Western	...	6,130	3.13	2.91	3.65	3.97*	...	...	...	3,985	31,179	8" conc., 1½" Ky rock, 3" sh. asph. 3½" brick, sand cushion, asphalt filler.
Mt. Vernon	1,090	1,425	2.94	3.54*	3.75	...	...	...	...	435	7,439	Std. conc. sec., 2" Ky. rock, 3" Trin.

Total area under contract—70,185 square yards. Total contract cost—$326,094. Total sewer cost—30,059.
*Contract awarded on this basis.

future, I am inclined to believe that we should use a somewhat heavier cross section, possibly a slab with a uniform thickness of 8 or 9 inches, reinforced with bars instead of mesh.

UNIT COSTS

The accompanying table gives the low prices bid on the various street paving contracts awarded thus far this year. It will be noticed that alternate plans were provided in nearly all instances. Our general policy is to take bids on several different types of pavements, whenever such types are suited to the particular conditions, in order to secure competition



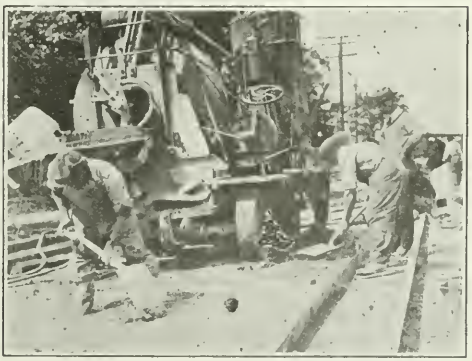
CONCRETE HEADERS BETWEEN WOOD BLOCK ON THE SHOULDERS AND BRICK NEXT TO TRACK.

among the material men as well as among the contractors. After the bids have been opened, read, and tabulated, the final decision as to type of surface is made, and the contract awarded to the low bidder on that type. While we are not required by law to award the contract to the low bidder, we have done so during the last two years, except in cases where the low bid was irregular for some reason. In such instances we have readvertised the work.

The type of surface on which the award was made in each contract is indicated in the table by an asterisk following the price on that particular surface. The table also gives, for each job, the area involved in the improvement, the amount of grading, the total contract cost of the sewer work included, the total amount of the contract, and general remarks regarding the type of cushion, filler, depth of wearing course, and so forth. The prices bid for the paving cover the grading but do not include curb. Where no yardage is indicated the grading included simply the excavation necessary to make room for the pavement.

It will be noticed that the bids varied from $3.75 to $4.46 per square yard in the case of brick, from $3.45 to $4.75 per square yard in the case of sheet asphalt, from $2.67 to $3.94, in the case of Kentucky rock asphalt, from $2.30 to $3.71 in the case of concrete; and that a bid of $4.94 per square yard was obtained on the renapped Medina stone, a bid of $5.00 per square yard on wood block, and a bid of $7.94 per square yard on granite block. These prices are from 5 to 30 per cent higher than the low bids on similar jobs last year. Reinforced concrete alley pavements are costing from $2.25 to $2.90 per square yard this year, as against $2.09 to $2.50 last year.

In the case of the brick pavements, where bids were frequently received on both types of cushion, the mortar cushion bids were generally from 10 to



LAYING BASE FOR ROCK ASPHALT SURFACE. One-bag Foote mixer used. Shows steel plate header between asphalt and brick surfaces.

20 cents per square yard higher than the sand cushion bids. Wood block bids on the basis of oil "A" have generally been from 10 to 20 cents per square yard higher than bids on the basis of oil "B." Bids on Trinidad asphalt have been about 10 cents per square yard higher than bids on oil asphalt.

Concrete combined curb and gutter, 12 inches deep at the back, 6 inches thick, with a 15-inch gutter, is costing from 70 to 90 cents per lineal foot for the straight sections, and from 90 cents to $1.40 per lineal foot for the circular, prices which are about 10 per cent higher than last year. Concrete curb alone, 6 inches wide and 21 inches deep, is costing practically the same as the combined curb and gutter. Both types are built with a 1-2-4 mix, and are set on a 6-inch gravel foundation. Catch basins in place are costing from $35 to $55 each; inlets, from $15 to $20 each; and manholes, from $40 to $55, prices which are about the same as last year.

ASSESSMENTS

The Dayton Charter provides that "The city shall pay such part of the cost and expense of improvements for which special assessments are levied as the Commission deems just, which part shall not be less than one-fiftieth of all such cost and expense; and in addition thereto the city shall pay the cost of the intersections." The Charter also provides that special assessments upon property benefitted may be made in three ways, first, by a percentage of the tax value of the property assessed; second, in proportion to the benefits received; and third, by the foot frontage of the property abutting on the improvement. Consequently, the general practice in recent years has been for the city to pay the cost of paving the intersections and 2 per cent of the cost of paving the portions in front of private property. The remaining 98 per cent of the property portion is assessed either by the foot frontage or by benefits, generally by the former method. Property owners are given the opportunity of paying their assessments in cash. If not paid in 30 days the assessments are certified to the county, and collected, with the taxes, in nine annual installments.

Repaving costs have been assessed by the same methods in the past, but will be assessed differently in the future—exactly how is not yet definitely determined. A recent supreme court decision held that on repaving jobs only half the cost can be assessed against the abutting property. An act, passed by the Ohio Legislature at its last session, provides that on repaving projects the property owners must be rebated for half the original assessments, amounts which are, of course, much less than half the present cost.

EXCAVATING TO GRADE WITH A THEW SHOVEL AND ¾-YARD BUCKET.

In the case of Brandt street and Western avenue, which are connecting links between city thoroughfares and county pikes, and which are being handled by the county, the county pays one-third the cost, the city one-third, and the abutting property owners one-third; first deducting, in the case of Brandt street, the cost of the paving in the car tracks and 18 inches outside, which portion of the cost is assessed against the street car company.

Sewer and water connections are installed by the city, prior to the paving, if they have not been installed by the property owners after being ordered to do so. The costs of such installations, if not paid in 30 days after the bills are rendered, are certified to the county and collected with the taxes in one installment.

Thus far the city at large has paid the entire cost of all storm sewers, whether main drains or street laterals. While the city has the right to assess the cost of such improvements, the officials naturally hesitate to make such a radical change in procedure. To do so now would be placing an unfair burden on the people who have no storm sewer but who have, for years, been contributing to the cost of construction of such improvements in other parts of the city. However, such a change is being contemplated in the case of repaving work.

With the exception of the streets paved in cooperation with the county, the paving work in Dayton is handled by the Division of Engineering, one of the subdivisions of the Department of Public Works. George F. Baker is Director of Public Service and F. O. Eichelberger is City Manager. W. O. Pease, County Surveyor, has charge of the work handled by the county.

Stream Pollution in Virginia

Early in October Commissioner Lee of the Virginia Department of Game and Inland Fisheries called a conference of representatives from several towns to consider the obtaining of legislation for preventing the pollution of streams. An effort will be made to prevent pollution by factories in so far as this can be accomplished by preventing the establishing of new factories which would cause such pollution. It is not expected that the General Assembly will cause existing factories to shut down, but it is said that the proprietors of factories have shown a desire to do what they can in ameliorating the present conditions if this does not necessitate a heavy expenditure. It is possible that a commission will be appointed to study this matter.

Heavy Traffic in Chicago

Fifth Avenue, New York City, is frequently cited as an example of a heavy-traffic street and even as carrying the heaviest traffic in the country. However, it is reported that an actual count of traffic over the Michigan Avenue Link Bridge in Chicago shows it to exceed the Fifth Avenue traffic by nearly 50%, 53,014 vehicles having crossed this bridge between 7 A. M. and midnight, with a maximum of 4,360 during the rush hour.

Renewing a Sewage Treatment Plant

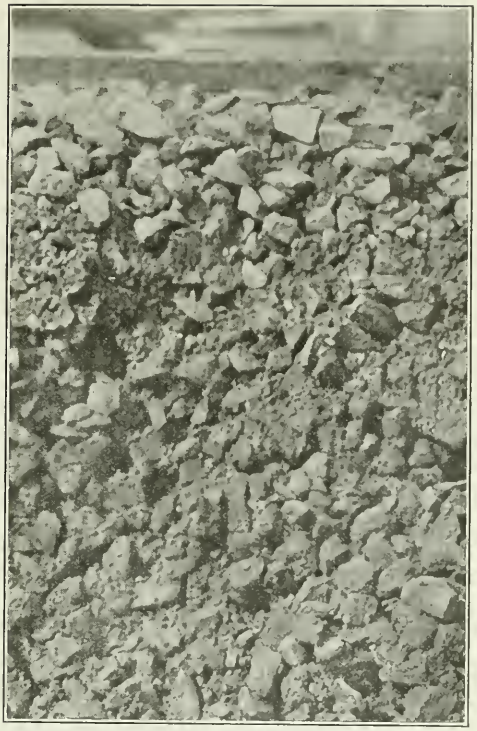
By W. A. Hardenbergh

Effluent of septic tank improved by insertion of baffles, and capacity of contact beds doubled by washing stone by means of home made apparatus.

Liberty, N. Y., is served by a small sewage treatment plant consisting of two septic tanks, four contact beds, each 40 feet by 90 feet, and four strainer beds of fine cinders. The effluent is discharged into a fair-sized creek. A rather full description of the plant was given in Municipal Journal, September 17, 1914.

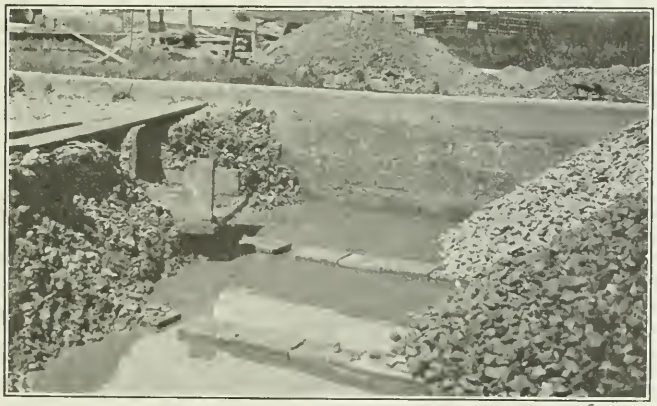
The population of the village has been increasing steadily since the plant was constructed in 1898 (the plant was rebuilt in 1908, but not enlarged) and during the summer season—for Liberty is a popular summer resort—there are six or eight thousand people contributing sewage to the plant. The normal flow of sewage for nine months in the year is about 250,000 gallons a day; during the summer months this increases to about 350,000 gallons daily. The result has been a heavy overload on the plant, partly because it was not designed to treat so much sewage, and partly because maintenance has been neglected.

During the summer of 1922 the problem became so serious that the village secured an engineer to report upon it. An examination showed that baffles were lacking in the septic tanks, resulting in short-circuiting, that the contact beds were badly clogged and in need of cleaning and replacement, and that the strainer beds were being operated incorrectly and at too high a rate. Faced with an immediate problem, it was not possible at the time to make any permanent improvements, but an attendant was hired and the plant given careful full-time operating attention.



CONDITION OF STONE BEFORE CLEANING.

Among the temporary improvements was the adjustment of the contract and resting periods for the contact beds, resulting in a vastly improved effluent; the leveling, raking, and regular operation on schedule of the strainer beds; putrescibility and efficiency tests; and the keeping of proper records by a full-time operator. This carried the plant through the summer in fairly good shape, but it was recognized that work would have to be done to prepare the plant for the 1923 season.



STONE BEFORE AND AFTER CLEANING.
Shows underdrains and seepage water.

The village, during the winter, voted $7,000 for repairs to the plant upon the advice of the engineer. It was not considered necessary to build a new plant, but considerable repairs to and proper operation of the old plant was demanded. The repairs needed included the construction of baffles in the

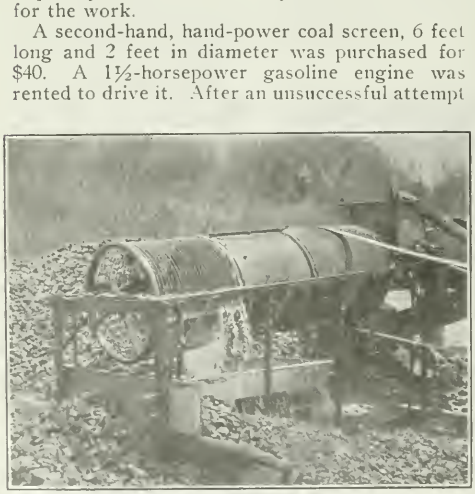
GENERAL VIEW OF STONE WASHING PLANT.

tank, the rehabilitation of the contact beds, and possibly repairs to the strainer beds. Work was absolutely necessary on the contact beds, which were clogged beyond any usable stage. Septic tank effluent could not be discharged into the stream; the strainer beds would not handle the tank effluent without further clogging, and the effluent from them when handling tank effluent was not good. Washing or replacing of the stone in the beds, therefore, appeared to be necessary. Tests indicated that the voids in the contact beds averaged 12%; in some beds it was less.

The cost of suitable stone delivered at Liberty was $3 per yard, with an additional $2 a yard for hauling to the plant, and $1 for placing. Removal of the old stone was estimated to cost $1 a yard, a total cost of $7 a yard, or about $12,000, for the replacement of stone in all four beds. It was believed that it would be much cheaper to wash the old stone and replace it in the beds, and this was decided on.

A search of engineering literature did not yield much data on methods or costs of washing contact bed stone in such small quantities. Consequently it became necessary to devise methods for the work.

A second-hand, hand-power coal screen, 6 feet long and 2 feet in diameter was purchased for $40. A 1½-horsepower gasoline engine was rented to drive it. After an unsuccessful attempt to use the chain drive furnished with the screen, a belt was run from the engine pulley around the body of the screen, as shown in the illustration. This solved the problem, though later events proved a slightly larger engine would have been better. It was thought that water would have to be held in the screen in contact with the stone for a period of time to insure proper cleaning. To attain this, the first two of the three screen sections were lined with sheet iron, leaving only the last section open.



SCREEN USED FOR WASHING STONE.

Water under pressure was not available, so another gasoline engine was rented and connected to a small pump. This drew water from the creek and forced it under a fair pressure to the washing apparatus. A hose and nozzle made the water supply flexible.

It was decided to handle the stone by barrows and shovels. A platform, with runways, was built at the screen. Stone was dug out of the bed, taken in barrows to the screen, washed, and returned to another part of the bed, previously excavated. In this way, considerable extra handling of the stone was avoided. A stock-pile of about 50 yards was maintained.

The stone was forked into the screen, through which a stream of water was directed. The stone issued from the screen almost absolutely clean. The equipment gave little trouble, though the screen lining wore out and had to be replaced for each bed (400 cubic yards). The main difficulty was in getting stone to the screen. Forks were found superior to shovels for handling the stone, if a smooth bottom was available. When stone could be brought to the washer in sufficient quantity, 5 to 10 yards an hour could be washed, but in practice there were few days in which more than 35 yards of stone were handled. The average was less, with delays, being about 20 yards a day.

As shown in the illustrations, the stone was very dirty, but in good condition otherwise. The loss from disintegrated or too small stone was very small. When replaced after being washed, the stone appeared in all respects as good as new.

The cost of washing the stone ran over the estimate, but was much less than the cost of replacement. The first bed cost just about $1,000 to wash, or $2.50 a yard, which is about the average cost including overhead, gasoline, etc. The original estimate was $1.50 per yard. Labor proved very hard to get. In fact, it was impossible to keep enough men on the job to maintain the work at full speed. Trouble was also caused by water and sewage seeping into the beds, requiring that the men work in 6 to 8 inches of water at times. Cleaning of the subdrains, which were badly clogged, was another item of expense not contemplated in the original estimate.

Two beds and part of a third one were cleaned in May, after which the work was postponed until fall, mainly because of labor shortage. Work on washing the remainder of the stone was begun early in October, and is being carried on at the usual rate of 20 to 25 yards a day.

The results of the work on the beds cleaned last May have been extremely satisfactory, especially when coupled with the improvements to the septic tanks. The capacity of the contact beds was doubled by the washing, while the effluent from the septic tanks appears to be considerably improved. For the first time in years there was no mid-season problem at the Liberty plant. The only trouble occurred late in the season when a local creamery discharged several hundred gallons of milk plant wastes into the plant, temporarily putting it out of order and creating a considerable nuisance from odors.

In addition to the washing of the stone, additional baffles were constructed in the septic tanks, and provision made for mixing the effluent from the strainer beds more intimately with the creek water. The baffles were constructed of hollow tile, so placed as to utilize most effectively all the space in the tanks.

Labor for washing the stone was paid $5 and $6 a day of 9 hours, and the foreman $8 a day. Even with this wage scale in force, men were very difficult to get; the work was hard and disagreeable. Including lost time, from 15 to 20 working days were required to wash each bed.

The work was under charge of the Board of Sewer Commissioners of Liberty, Fred Grimm, Walter Randall and Harold O. Weyrauch. To the last is due much credit for planning the ingenious devices used on the work, and for the solution of difficulties which arose from time to time.

American Road Signs

Curious instances of misinformation concerning American affairs published in English papers occasionally come to our attention and we wonder where they obtain such items as the following:

"There are few towns or even villages in the United States which are not provided with signs giving not only the name thereof but affording other information of a useful character to visitors, and these are invariably constructed of concrete." The "invariably" looks like propaganda of the cement manufacturers. Our observation would lead us to consider even "occasionally" as highly flattering.

Business Street and White Way Lighting*

Facilitating traffic by night aids in remedying traffic congestion. Requirements of lighting for main and secondary business streets, as to density, color and distribution of light, and appearance of lighting units by day.

While the fundamental idea of street lighting is to aid in the prevention of accident and crime, it has a secondary value as an advertising medium for the city or town. Ornamental and high intensity lighting are found to have high advertising value for business streets. From small beginnings with temporary white way lighting for celebrations the idea has spread until now permanent installations are found in business sections of both large and small cities.

Such lighting affords a distinct gain in business efficiency by increasing the hours during which a safe and comfortable use of the streets is possible. In addition, bright light exercises a definite attraction for almost everyone. Specific instances could be cited where, when certain commercial streets only of a city have been equipped with brilliant lighting, they have gained in evening traffic over the poorly lighted ones in a ratio of 2:1 or even 3:1. There is the added advantage to the citizens that well lighted business streets permit those who are engaged during the day to do their shopping with comfort and pleasure during the evening hours.

By so lighting city streets as to permit night traffic of the same density, safety, speed and convenience as by day, and thus facilitate continuing traffic during more hours out of the 24, traffic congestion is greatly relieved, and the time when duplicate construction of streets or of pavements suitable for heavy traffic will be required is postponed for years in many cases, provided a large percentage of the traffic can be diverted from the crowded day hours. A well-known electrical expert has estimated that reductions in trucking cost as great as one-half would be possible by the increased utilization of equipment and terminal facilities and the avoidance of traffic delays, if streets were used by a large part of this traffic during the less congested night hours.

This subject of the lighting of business streets has been studied comprehensively by Earl A. Anderson and R. E. Greiner, illuminating experts, among others, and much of the material in this article is derived from their researches.

It is essential in considering a plan of street lighting to observe carefully the different requirements of each class of street to the end that the available money set aside for the purpose will do the greatest good. The business streets and thoroughfares will, of course, require the greatest amount of illumination, for in this section there is congestion of foot, vehicular and street-car traffic. The principal thoroughfares leading from the center of the city, and also the streets in the wholesale and manufacturing districts, carry much traffic of a high-speed nature and must be lighted accordingly.

*Published through the courtesy of the Electrical Industry's Joint Committee for Business Development.

STREET IN EAST CLEVELAND, OHIO.
1,000 c.p. lamps attached to 6-foot bracket arms 20 feet above the street; staggered, one lamp per 150 feet of street.

small lamps which were in vogue before the introduction of the high-powered, gas-filled incandescent lamp.

There is at present a very noticeable tendency to depart from the use of the opal ball or globe, and to use instead a lantern structure, which is considered by many to be more pleasing in appearance. Cleveland was the first large city to adopt equipment of this character and has many hundreds of most attractive standards using 1000 and 1500-candlepower lamps. These lanterns are glazed with a ripple glass and are used with prismatic refractors which increase the amount of light delivered to the street by turning downward the light rays which in an ordinary opal globe are largely lost.

Instead of the single-lamp standards spaced rela-

The highest intensity of illumination in the principal business streets of large cities at the present time is not greater than would be desirable for all streets of the city, were it not for the cost. But because of the very great areas to be covered and the very limited appropriations available, it may be impracticable to provide more than perhaps one-tenth as much light in the residential streets as in the principal business section.

STREET IN SEBRING, OHIO.
600 c.p. Mazda C lamps mounted 13½ feet high, spaced 90 feet.

LIGHTING BUSINESS DISTRICTS

As the commercial life of a community is centered in its retail business district, the illumination here should be of the highest order. It should provide: (1) A high density of illumination to attract the crowd, increase business and prevent accidents from dense traffic; (2) The most effective quality with regard to color, diffusion of light and freedom from glare; (3) A distribution so controlled as to give sufficient illumination on a street surface and at the same time allow sufficient light to strike the buildings and make visible the architectural details: (4) Units of such a character as to give an attractive appearance by both day and night and harmonize with the character of the buildings and carry out the traditions of the community.

A distinctive character of white way illumination is that more lighting is demanded between street intersections than on the corners themselves, whereas in all other classes of street lighting the maximum is required where the lines of traffic cross. The reason for this is that the decorative and publicity functions call for more light than would be required for reasonable safe travel.

For important business streets in cities, the most widely favored method of lighting consists in the use of single-light ornamental standards mounted at heights of from 14 to 25 feet and spaced opposite each other at distances of from 60 to 120 feet. For very narrow streets the lamps may be placed on one side only or staggered at the same spacing. An important increase in efficiency is secured by the use of lamps of 600, 1000, 1500 or 2500 candlepower instead of the three, four or five-light clusters using tively close together, some cities have adopted standards carrying two or even three high-powered lamps mounted from 20 to 30 feet above the street and spaced from 150 to 200 feet apart. The resultant effective illumination is not greatly different from the more usual arrangement and the exceptionally high mountings minimize any possibility of glare from the lamps. On the other hand, there appears to be much weight on the side of those who contend that on business streets the surrounding brightness of buildings, show windows, etc., is such that there is no possibility of serious glare, even with the large lamp at the lower mounting of from 15 to 18 feet, and that the desirable white way effect is enhanced by lanterns at the lower heights spaced 80 or 90 feet apart.

The demand for higher levels of illumination on business streets has led in some cities to the consideration of lamp standards carrying two or three 1000 or 1500-candlepower lamps each and spaced no more widely than previous single-lamp installations. It is quite possible that there will be an increased development of this tendency, especially in the larger cities where the crowds from evening business and amusements have become such that in many cities white way systems which were installed quite largely as an ornamental or advertising feature are even now barely adequate from the standpoint of lighting for safety.

SECONDARY BUSINESS STREETS

In each city there are less important business streets adjacent to the main business street, and those smaller business centers which spring up in

semi-suburban districts of all kinds. On these streets it is obvious that the intensity of illumination will be somewhat lower than on the streets of the principal business section. It should, however, be of a comparatively high standard. But there is not the same demand for the publicity element, and traffic is not likely to be so heavy on this type of street, making a slight decrease in illumination possible without increasing the number of accidents. There will still be provided ample illumination for the prevention of crime.

In general, the ornamental system used "downtown" should be continued on the secondary business

WHITE WAY LIGHTING IN YOUNGSTOWN, OHIO.
1,000 c.p. Mazda C lamps at 90-foot intervals.

streets to preserve the uniformity of appearance. It is, however, sometimes necessary to allow a somewhat wider spacing or smaller lamp, or to use a more economical method of lighting. In this case a pendent-type unit with diffusing globe would be recommended. Refracting equipment is generally desirable with either type, especially if the spacing is fairly wide.

Because of development of refracting equipment, the distribution of light from street lighting fixtures can be accurately controlled to give the maximum candlepower at any desired angle. This is ordinarily 10 to 15 degrees below the horizontal. The directional effort is secured by means of a prismatic glass refractor, the prisms being so designed as to refract the light given off by the lamp into the desired direction.

The buildings lining the secondary streets are not so high as those along the main business section and the streets are somewhat narrower. In mounting the units, if the ornamental type is used, the same style standards are employed as on the main business street with a wider spacing or a somewhat lower mounting height and smaller lamp. If the ornamental type of unit is used, 400, 600 or 1000-candlepower lamps should be employed, spaced 100 to 125 feet, and mounted at from 13 to 18 feet. If pendent units are employed, the lamp is mounted on a mast arm and swung over the street. In this case, the lamp sizes and spacings should be the same, but the mounting height should be from 15 to 20 feet.

Water Divining in England

We occasionally hear of instances in this country of the alleged location of underground water by the use of twigs of hazel or other trees in the hands of a "water diviner," but so far as we know this practice is not taken seriously by any educated people. However, in England, this use of water diviners or "dowsers," as they are called there, appears to receive even the official sanction of the highest authorities in the Government. Dozens of cases have been reported during the past year or two of the employment of dowsers by different English municipalities, one of the latest being the engagement by the town council of Chelmsford of two young ladies who are reputed to have inherited their water divining powers. One taxpayer who did not appear to be convinced of the reliability of this method of locating underground water inquired of the Minister of Health whether local authorities were authorized by the Government to invest public funds in water divination by dowsers, and was informed by the Minister that "reasonable expenditure" for this purpose was authorized by the health authorities.

STREET IN TOLEDO, OHIO.
300-watt Mazda C lamps in rippled globes, two to a pole, poles spaced 100 feet apart.

Sewage Pumping in Jacksonville

By W. E. Sheddan *

Six pumping stations lift sewage from several low and distant areas into the river. Enlarging pump well increased capacity of trunk sewer. Automatically controlled pumps installed.

Jacksonville, Florida, is fortunately located at a bend of the St. Johns river, which forms the boundary on two sides and provides adequate and comparatively simple means of disposal for the city's sewage. However, owing to the flat terrene, with comparatively low elevation, it is necessary to divide the system serving that portion of the city along the riverfront into numerous small outfalls. Many of these in time will have to be emptied into an intercepting sewer and carried out into deeper water, but it is doubtful if treatment methods will ever have to be resorted to.

The highest part of the city is only 37 feet above mean low water in the river, and this is a small area which is only about a quarter of a mile back from the river; whereas the larger areas back one and two miles from the river have an elevation ranging from 15 to 27 feet. To boost the sewage out into the river from these back areas requires six sewage pumping stations, ranging from a small station handling somewhat less than one-third of a million gallons of raw sewage daily, to one handling over two million gallons daily; this quantity being somewhat increased in wet weather due to seepage and a certain amount of roof drainage that gets into the system.

This last station handles sewage from a strictly residential section of the city comprising approximately 900 acres, about one-half of which contains a better class of residences—two to four-family houses —with a number of apartment houses scattered about; while the rest has been built up with a cheaper class of cottages housing a negro population. This area is provided with two trunk line sewers, one a double line of twelve-inch pipe extending eastward and northward, and the other a fourteen-inch trunk line extending to the westward and northward, the two forming somewhat of a "U" shaped trunk system with secondary trunk and laterals covering the territory, with the station located in the lower part of the "U."

About four years ago this system began to show signs of distress from overload. Studies of the problem were started to determine the best way to relieve this condition. It was at first thought that it would be necessary to rebuild the westerly trunk line or provide a relief pipe line paralleling it, but as this would require a rather large expenditure of money, which was not to be had at that time, our studies reverted to the pumping station.

The old station comprised a receiving well, circular in shape, 30 feet in diameter and 12 feet in depth, the bottom being elevation minus 7.5′, all of the sewage emptying into this receiving well near its bottom. The pumping equipment comprised two 3,000-gallons per minute horizontal type centrifugal pumps, direct connected to 220 volt, three phase, 50 h.p. A. C. motors, discharging into a 14-inch force main, which carried the sewage over a rise emptying into an 18-inch gravity line, which carried the sewage about three-quarters of a mile by gravity into the river. The total head against which these pumps were working was, with the sewage low in the well, some 25 feet. These pumps were hand controlled and operated intermittently, the well being allowed to fill, which necessarily backed the sewage up in the entire system for a distance of one mile. This condition alone materially reduced the capacity of the system. Moreover, the size of the force main being so small, only one pump could be operated at a time. Both outfits were old and somewhat worn and were not at all adapted to meet conditions.

A study was made of the flow and quantities of sewage, over a period of weeks, readings being taken 24 hours each day. In this way the minimum and maximum rates of flow were fairly accurately determined, as well as the total quantities pumped each day during this period, which was fairly typical of normal conditions.

It was decided to construct a dry pit eight feet from the receiving well and place in it two bottom suction centrifugal pumps with 14-inch suctions to the well. Each pump is designed to pump 1,600 gallons per minute; they are direct connected to 25 h.p., three phase, 220 volt A. C. motors, and are equipped with automatic starters, phase controls, and are the most modern type. They have been in service for one year, giving entire satisfaction, and accomplishing the desired relief to the system.

In operating this station the float controls are so set as to keep the sewage at a low level in the receiving well; one of the pumps running practically all the time and the second pump cutting in over the peaks, when the flow is greater than one will handle. In this way we prevent the backing up of sewage in the system mentioned above, and, in our opinion, have increased the capacity some twenty per cent or more, and have actually shown a less current consumption,

INTERIOR OF PUMP HOUSE—MOTOR AND CONTROL SWITCHES.

*City Engineer of Jacksonville, Fla.

NEW SPRINGFIELD PUMP HOUSE OVER DRY PIT AND OLD PUMP HOUSE OVER RECEIVING WELL.

Smoke stack has no connection with station.

and have been able to discontinue the services of two pump operators at this station. The equipment in the old station has been left in place, and one outfit, reconditioned, is available for emergency use.

The dry pit and pump house were constructed by Benj. Thompson as contractor, at a cost of $2,005.18; pumping equipment was installed by Buford, Hall & Smith of Birmingham and Atlanta, at a cost of $4,587.00, the pumps being the "Yoeman's" make, with direct connected G. E. motors.

By installing automatic controlled, submerged type of pumps in our other five stations, one pump mechanic at $140 per month now easily cares for all six stations, where formerly it required the services of six operators at $90 per month each. This alone shows a material saving to the city, to say nothing of added efficiency, and the saving of worry and trouble from antiquated installations.

Lining Canals

Concrete 1.5 inches thick reduced seepage loss by 50 to 90 per cent., increased carrying capacity, and reduced cost of maintenance by 60 per cent.

For several years past the canals of the Orland irrigation project in California have been receiving a concrete lining, a little each year. The results obtained indicated decided economic advantages, which would apply to canals for water power or any other purposes.

The canals lined varied in bottom width from 3 feet to 15 feet and in vertical height from 1.5 to 4.75 feet, with side slopes of 1½:1 and 2:1. They were lined with concrete 1½ inches thick the bottom and slope of course being first dressed to uniform surface.

During the season of 1922-1923, 77,919 square yards of lining were placed, the length of the canal being 9.05 miles. This required 2,883 cubic yards of concrete. The costs averaged 39.5c per square yard for lining or $10.70 per cubic yard of concrete. The unit costs per square yard averaged as follows: Preparing section for lining, 7.6c; cement, including hauling to field, 13.0c; gravel, 5.0c; mixing, 2.5c; placing, 4.2c; finishing, 0.5c; sprinkling and protecting, 0.2c; water, 0.4c; repairs and supplies, 0.3c; equipment charge, 0.5c; giving a total for labor and material of 34.2c. To this was added 0.2c for superintendence; 0.7c for engineering, and 4.4c. for general expense. Prior to 1916 the lining was placed at a cost of 27.8c for labor and material and 6.5c for overhead, labor then receiving $2.50 per day and cement costing $2 per barrel.

The advantages of lining are: The reduced cost of maintaining the lined sections, reduced seepage losses, and greater carrying capacity. Comparative costs of maintaining earth and concrete lined sections on this canal are available covering 66 miles of earth and 31 miles of concrete-lined canal, and these show a cost of $55.70 per mile for earth, and $19.50 for concrete-lined sections during the season. The work of cleaning earth sections is performed with teams and scrapers and consists in the removal of silt deposits and all plant growth. In the lined sections small silt deposits are removed by hand and minor repairs are made to the lining. (1½-inch lining placed in 1911 and in continuous use since then is still in excellent condition with no indications of disintegration or failure.)

By means of current meter measurements and discharge over weirs, seepage and evaporation losses of canals located in the different soil locations of the project and in the concrete-lined sections have been determined during each irrigation season since 1912. The mean results give the following losses in feet per day per unit of wetted perimeter: Concrete lined, 0.29; clay 0.63; gravelly clay, 1.38; loam, 1.40; gravelly loam, 1.47; sand and gravel, 2.85. The evaporation would presumably be the same in all cases, so that the differences indicate those due to the soil or lining and that the loss is less than half as much with concrete lining as with clay.

Another advantage is that the capacity of the canal is increased, not only because of absence of vegetable growths, but also because greater velocity can be maintained with safety. Also there is comparative freedom from washouts and breaks.

Hydrant Rental in Omaha

In 1911 the city of Omaha, Nebraska voted 8½ millions of bonds to purchase the water plant and to make extensions and improvements. The bonds contained a proviso that the city, in order to insure the payment of interest, would levy an annual water tax, and under this proviso the city is now compelled to pay $191,000 a year as fire hydrant rental under the statute adopted. The waterworks plant has made all necessary payments to date, has retired $600,000 of the 7½ millions actually sold, and has in the sinking fund $1,700,000 in excess of the requirements for interest and maturing bonds.

The city council, desiring to reduce taxes, proposes to discontinue the payment of hydrant rental, declaring the law above referred to unconstitutional, and refused to levy taxes for this purpose this year. The Water Board then obtained an order o'

mandamus compelling the making of the levy, from which the city has appealed declaring that it was no business of the Water Board as to whether what the Council did was legal or illegal, the Council being responsible only to the voters of the city, and claiming that the provision contained in the bond was illegal, and if legal was not irrevocable.

Water Main Joints in St. Louis

In his latest annual report, the water commissioner of St. Louis, Edward E. Wall, describes an investigation made of jointing materials used for cast iron pipe. The investigation was made in connection with a study of electrolysis and methods of preventing it, the idea being to make the mains as nearly non-conducting as possible by using non-conducting materials for all the pipe joints.

Pig lead, the standard joint material, is a better conductor than the cast iron itself. This fact, together with the rising price of lead, formed the incentive for a series of electrical resistance tests which were recently made on three lines of 3-inch cast-iron pipe, one laid with lead joints, one with cement and the third with leadite, an old established patented compound which requires no caulking. After finishing these tests, both with the pipes full of water and empty, the lines were put through a very severe deflection test by raising and lowering one end with a derrick.

A summary of the conclusions from this test is given by Mr. Wall as follows:

1. Cement and leadite are far superior to lead as insulators and the insulating value of these materials is not vitiated by the water in the pipe. Their use would have prevented most of the electrolytic trouble to which our cast-iron system is subject at present. This statement is made in full cognizance of the fact that the insertion of an occasional insulating joint may lead to joint electrolysis caused by the current leaping around this particular joint and continuing along the pipe line. The point is that if every joint were insulated the current would not have the incentive to travel the main in the first place.
2. Cement and leadite will stand far more deflection than lead without serious leakage.
3. Lead and leadite joints can be made in any season and under adverse conditions, while cement is at a disadvantage in Winter and in wet trenches.
4. Lead and leadite joints permit the water to be turned on and the line put in service immediately, while cement requires a period of preliminary setting.
5. Cement joints are very hard to gouge out.
6. The sulphur fumes given off by the melted leadite might become very oppressive in a confined space.

Cement Lined Cast Iron Pipe

Reference was made in Public Works a few months ago to the recent experiments of the Water Department of Charleston, S. C. in lining cast-iron pipe with cement. In his annual report for 1922, J. E. Gibson, manager and engineer of the Water Department, reports on the work done in this line up to the end of the year.

For several years the Department had been dissatisfied with the protective coating used on cast-iron water mains as used with the Charleston water. Mr. Gibson had had considerable experience with the use of cement-lined wrought-iron pipe as manufactured by the American Pipe and Construction Company under the Phipps patent, which has now expired, and made an arrangement with the American Cast Iron Pipe Company of Birmingham to undertake experiments in the manufacture of cement lined cast-iron pipe. A plant for this treatment and a process were finally perfected so that satisfactory pipe was turned out by May. 15th, 1922 and the actual manufacture of pipe commenced about June 5th. In arranging for these experiments, the city had agreed to take about 15,000 feet of 6-inch, 12-inch and 16-inch pipe if a satisfactory product could be obtained. At the end of the year it was reported that the city had in service 1183 feet of 4-inch cement-lined cast-iron mains, 17,681 feet of 6-inch, 822 feet of 8-inch, 1,578 feet of 12-inch and 12,431 feet of 16-inch.

Experiments were made upon sections of 6-inch and 16-inch cement-lined pipe to determine the value of the co-efficient C in Hazen & Williams formula for flow of water in mains, and the values determined from these experiments indicated a much higher carrying capacity of cast-iron pipe when lined with cement than when given the ordinary coating. Moreover, the department feels that the high value would be maintained indefinitely, as examinations of other cement-lined pipe in use from 25 to 30 years have shown no signs of tuberculation or incrustation. An additional advantage is that the cement lining effectively prevents rusting of the interior surface and will presumably reduce red water troubles for consumers.

"The department has, therefore, adopted cement-lined cast iron pipe for all future extensions within the city limits and on all improved streets."

Locating Water Pipe Leaks*

What is going on underground is often a matter of such importance and yet so uncertain that it may be of interest to water works men to hear of some experiences with the geophone, a development of underground war operation to detect enemy mining and sapping.

The instrument exteriorly consists of two discs, each about 1 inch thick and 4 inches across, from each of which leads a tube ending in an earpiece. The whole affair is not unlike a stethoscope.

In use the discs are placed on the road surface and an earpiece in each ear. If a leak is suspected in a given locality, by placing the two discs as far apart as the lengths of tubes permit, it will be found that the noise in one ear will be louder than in the other. The less loud disc will then be shifted backward and forward until the sounds from both are equal.

*Paper by Francis W. Collins, consulting engineer for the Roanoke Water Works Company, in the Journal of the American Water Works Association.

The assumption follows that the sound is in the plane perpendicular to the straight line joining the two discs. Mark this observation spot, then proceed along the direction of this plane forward or backward whichever way, on trial, intensifies the noise.

The time necessary to locate an ordinary leak when within 50 or 75 feet of it is usually only a few minutes and not over 15 or 20.

There are some points of interest worth following by one using the geophone for the first time:

(a) The operation must be carried on at a time of no traffic or other street noises. It was found that a street sweeping machine of the revolving broom type two or three blocks away on a brick pavement made so much noise that it was distinctly heard in the geophone. The early morning is practically the only time, except in outlying districts, the instrument can be used.

(b) The operator must learn what to listen for. He may pick up all kinds of noises.

(3) The noise from a leak, apparent through the geophone, will depend on against what the leaky water impinges. If the stream is against a ledge of rock, a roar like a cataract may result; the volume of sound does not necessarily indicate the size of the leak. No observations have been made as to the effect produced by different characters of apertures through which the leak might be taking place.

Although not tested under all conditions so as to determine what the geophone will not do, enough has been learned through its use to prove its value for what it will do. We are now interested in learning the smallest leaks it will disclose and under what conditions.

Three examples will show what it will do:

(1) A ½-inch service 2½ feet deep, leaking a stream smaller than a lead pencil, under 8 inches of brick and concrete base pavement was heard fifty feet away (how much farther it might have been heard was not determined) and was located exactly, saving nearly the cost of the geophone through not having to cut up the pavement. There was no surface indication of where the trouble was. It was only known that there was a leak in a certain block.

(2) A leaking half-inch service in a 6-inch reinforced concrete pavement, 3½ feet deep, was located. Before starting, the suppositions were that a joint in a 16-inch main might be blown, or a valve was leaking, or a service had gone out. The geophone got on the job and left no doubt that a service was involved and located the exact spot at which to break through the pavement with a consequent saving in cost. It was only necessary to open the concrete pavement enough to permit a man to work.

(3) The local gas company was laying a main parallel to ours and discovered a considerable volume of water which was reported leaking from the water main. Inspection at fire hydrants, meter and valve boxes failed to disclose any leaks. The geophone was used showing no leaks whatever. Later it was proved that the water was ground water from a clayey soil.

The use of this instrument has been in the hands of Mr. Charles E. Moore, Assistant General Manager, and Mr. D. R. Taylor, Assistant Superintendent, of our Company, and I am indebted to them for the above data.

Dayton Waterworks

During the year 1923 the Division of Water of Dayton pumped 6,145 million gallons of water. Its receipts for the year amounted to $479,108. The operation charges totalled $171,857, while bond payments were made amounting to $233,487. In addition, the division gave, as is the case in most cities, a large amount of free service. Without crediting any of this free service, and including the bond payments with the operating charges, there was a net profit to the division of $73,764.

During the year the supreme court of the state decided that municipalities owning water plants cannot use the surplus revenue from such plants for any purpose other than the extension and operation of that utility. The city of Dayton had been using approximately $130,000 a year from the receipts of the Division of Water for its general operating expenses. Beginning this year, however, it has been necessary for the city to maintain a waterworks fund separate from the general fund. This, which has been the established practice in so many of the eastern cities, was apparently considered a hardship by Dayton and an effort is being made to charge against this fund 10 per cent. of the gross revenue to be paid to the city in return for the supervision of the waterworks service. $45,000 to $50,000 a year would seem like an excessive charge for supervision, over and above the amount presumably paid as salaries to the superintendent and others immediately in charge of the division.

Water Supplies from Valleys

Development of such a supply includes selecting location for wells, examining records of previous borings, study of geology, and comparison of available supplies.

In a paper presented before the Illinois section of the American Waterworks Association, W. D. P. Warren, consulting engineer of Decatur, Illinois, discussed the subject of obtaining ground water supplies from pre-glacial valleys, in which type of valleys, he stated, such supplies are generally found. He described in some detail investigations made for two cities in central Illinois as being somewhat typical. He then gave as a general statement, the following conclusions:

"The investigation for a new or of an additional water supply should be conducted along broad lines, keeping constantly in mind that such investigations may be properly extended a distance of five, ten, twenty or more miles beyond the city limits. A few comparisons in cost may show that a well supply may be developed at distances not heretofore seriously considered. The present lower cost of cast iron pipe and the high cost of reservoir lands, are factors which will influence a final decision.

"Keeping clearly in mind the fundamental principles which govern the development of a shallow ground water supply, and realizing the relation thereto of deposits in the pre-glacial valley, it will be of interest to consider proper methods of de-

velopment. These may be briefly summarized as follows:

"1. An examination of the extent of all possible water shed areas within reasonable distance. As a rough rule, we might say that a city of 2,000 population may economically develop a well supply at a distance of not over five miles, while a city of 50,000 might economically develop a well supply at a distance of not over fifteen or twenty miles, depending on availability of natural reservoir sites, relative elevations, cost of land, etc. The advantages of a well supply, with low first cost and low operating cost, will justify extending our investigations over a wider field than generally considered necessary.

"2. An examination of well records, test holes, borings and other data in the territory under consideration. Such records may often be secured from coal, oil or gas companies, local well drillers, and of most importance in this State, through the State Geological Survey at Urbana. Some such records are confidential, however, the portion relating to depth of glacial drift is not, and may generally be secured to be used in the investigation of a municipal supply.

"3. A thorough study of all available records with a view to determining the dip of the rock or shale at base of glacial drift and the location of pre-glacial valley. This study should be made before the location of any additional drill holes is considered. Often the elevations as disclosed by the records of two or three old holes will indicate the direction of the pre-glacial valley, and a little further investigation should definitely establish its boundaries.

"4. The application of knowledge obtained through above studies and the location of test holes in accordance therewith. Such test holes should furnish sufficient additional data to determine the possibilities of any site under consideration.

"5. With complete and accurate data upon these principles, a conclusion may then be reached as to the value of such a supply, compared with a surface supply, and recommendations may be made regarding future developments with a full knowledge that all facts relating thereto have been properly considered and analyzed."

Garbage Disposal in Dayton

The city of Dayton, Ohio, during 1922 collected garbage sufficient to load 399 railway cars at a cost for collecting, hauling and loading of $52,459. Of this amount of garbage, 375 carloads were sent to the garbage reduction plant and 24 to the city workhouse for feeding hogs. This latter amount was selected garbage of the best grade which had been collected from the hotel and restaurant district by daily collections. The cost of collection was calculated to be $2.37 a ton.

From the 375 carloads, or 18,750 tons, of green garbage delivered to the reduction plant, 934,805 pounds of grease was produced, or 49.85 pounds per ton of green garbage. The amount would have been greater had not the percolator broken down on Nov. 16th and the extraction of grease been discontinued from that date until the end of the year, during which time 5,100 tons of garbage was delivered to the plant. In removing the grease there were used 9,205 gallons of high-test gasoline. This average of about one-half gallon of gasoline per ton of garbage is considered very low.

The total quantity of tankage produced was 1,762,270 pounds, or 94 pounds per ton of garbage. It required 2,966 tons of coal to operate the plant, or an average of one ton to 6.35 tons of green garbage.

The total cost of operating the plant was $57,594, an average of $3.15 per ton of garbage. As the income from the sale of grease and tankage was $56,500, it is seen that this fell about $1,000 short of equalling the operating cost of the plant, without considering any overhead costs. This, however, is a much better showing than was made last year by several other reduction plants.

Disposal of Street Sweepings

Methods reported by nearly two hundred cities and tabulated elsewhere in this issue. Most dump their sweepings. Those of ten cities used as fertilizer.

The character of street sweepings has changed very materially during the past twenty-five years. Prior to that time a large percentage of the streets in American cities were macadam, gravel or earth, with only a few blocks in the business center paved with asphalt or brick. Consequently street sweepings contained large amounts of earth and gritty material from macadam stone. With the great increase in amount of asphalt, bituminous concrete, cement concrete and brick pavements, the amount of this mineral matter has diminished materially.

Even more essential has been the change due to substitution of automobile for horse-drawn traffic. With the great diminution in the number of horses on the streets, the amount of horse droppings in the sweepings has become very small in most cities, while the automobiles have contributed more or less oil to be absorbed by the dust on the pavement. This results in a considerable decrease in the fertilizing value of the sweepings combined with a direct disadvantage caused by the presence of oil in the material, which tends to clog the soil and possibly even inhibit vegetable growth.

In spite of the changes indicated above, several cities and villages reported, on the questionnaire sent out by us last month, that the sweepings from their streets are used for fertilizer. Of 189 municipalities reporting, five used the sweepings as fertilizer on parks, cemeteries or other property, while five report that it is used by private parties, three of them being able to sell the sweepings for that purpose. One of these, Napa, California, sells sweepings for the cost of hauling, which is estimated at 50c a yard. H. A. Harrold, city engineer and superintendent of streets.

writes us: "Five or six years ago when autos did not leave so much oil on the streets we sold them as fast as collected. Now, however, people who have truck gardens in their backyards do not buy them because they believe that the oil destroys the plants. Nevertheless we sell them to Italian ranchers who keep them until thoroughly rotted before using. . . . I expect some time in the future we will have to give them away to get rid of them." Purchasers furnishing their own wagons obtain the sweepings for 25c a load.

S. Cameron Corson, borough engineer of Norristown, Penna., reports that on the permanently paved streets of that borough the only dirt found consists of manure and leaves, and this is gathered up by property owners and stored as a fertilizer. Incidentally he states that, except in the business part of the town, the streets are not cleaned regularly by the borough but that the citizens have sufficient pride to each clean the street in front of his own property. The street sweepings, where they are not saved for fertilizer, are placed in ash receivers, the contents of which are removed by the citizens at their own expense.

Only about 5% of the cities, however, report the use of street sweepings as fertilizer. Seven municipalities report the burning of street sweepings, four of them in incinerators. One buries the street sweepings. The great majority, however, dump the sweepings at various points, some utilizing them as fill. Seventy-seven report merely "dumping," "dumping on low land," etc., 6 of them specifying that they are dumped along with garbage. Thirty-seven others specify that they are placed on public dumps and 4 on private dumps. Five others specify they are dumped outside the city, 1 in a gravel pit and 1 in a quarry. Four report dumping in a river or other body of water. Twenty-nine report that the street dirt is used for filling in land or low lots and 3 that it is used in grading up streets; 1 uses it for making land for a public landing, 1 for building a dike along the river and 1 uses it for covering ash dumps. Altogether 171 report disposing of the sweepings by dumping or filling in low land.

Even before the change in character noted above, there was not much danger of nuisance from the dumping of street sweepings if reasonable care was taken in selecting the location of the dump and keeping it in order. With the change in character noted, the objectionable features have considerably decreased in importance. While the fertilizing value of sweepings has decreased, there are possibilities in the suggestion from California that by storing the sweepings for some time the objectionable characteristics of the oil may largely disappear. The presence of grit, leaves, etc., is of value in lightening clay and other heavy soils.

DISPOSAL OF STREET SWEEPINGS AND GARBAGE

City	Disposal of Street Sweepings	Change in Disposal of Garbage This Year	New Method Contemplated	Reason for Making Change
Alabama:				
Florence	Incinerator	None	None	.....
Gadsden	Burned	None	.....	.....
Talladega	Dumps	None	.....	.....
Arizona:				
Tucson	Hauled to dumps	Dumping	Building incinerator	Flies and general nuisance of dumps
Arkansas:				
Fayetteville	Hauled to city dumps	.....	Building incinerator	Difficulty in finding satisfactory dumping ground
California:				
Monterey	Dumped outside city	None	Garbage disposal plant	To alter expenses
Napa	Dump and sell	.....	.....	.....
Redlands	Fertilizer on city prop.	.....	.....	.....
Santa Ana	Filling low ground	None	None	.....
South Pasadena	Fill	.....	.....	.....
Colorado:				
Denver	Fill low places	None	None	.....
Connecticut:				
Hartford	Public dump	None	None	.....
New Britain	Dumps	Private contractors	Change discussed	Irregular collections
New Haven	Public dumps	None	None	.....
New London	Dumps	None	None	.....
Willimantic	City dumps	None	None	.....
Florida:				
Key West	Filling low ground, city property, combustible matter burned	.....	.....	.....
St. Petersburg	Dump	None	To build 80-ton incinerator	Present incinerators of insufficient capacity
Georgia:				
La Grange	Incinerator	None	None	.....
Idaho:				
Lewiston	City dump	None	None	.....
Twin Falls	Dump and low streets	City hauling to private haulers	Contract with private company	Obviate expense & trouble of maintaining teams
Illinois:				
Canton	Fill low places	Regular collections	.....	.....
Centralia	Low lots and ravines	None	None	.....
Freeport	Dumped	.....	.....	.....
Kankakee	Dump in old quarry	Feeding to hogs instead of dumping in quarry	None	Bad odors
Oak Park	Dump	None	None	.....
Quincy	Dump in hollows	None	None	.....
Sterling	Dump	None	None	.....
Urbana	Haul to dump	None	None	.....
Winnetka	Village dump	None	Buy site for disposal plant	.....
Indiana:				
Bedford	Fill low lots	None	.....	.....
Brazil	Fill low land	.....	.....	.....
Elkhart	City dump	None	None	.....
Gary	Filling & burn for sts.	Feed to hogs	None	.....
Hartford City	People use for fertilizer	None	None	.....
Indianapolis	Haul to dump	.....	.....	.....

DISPOSAL OF STREET SWEEPINGS AND GARBAGE

City	Disposal of Street Sweepings	Change in Disposal of Garbage This Year	New Method Contemplated	Reason for Making Change
Indiana (Contd)				
Lafayette	Haul to dump	None	None	.....
La Porte	Haul to city dump	None	None	.....
Lebanon	Haul to dump	None	None	.....
Shelbyville	Haul to dump	None	Change of some kind probable	Collection by contract unsatisfactory
South Bend	Filling low ground	None	None	.....
Terre Haute	Haul to city dump	.....	.....	.....
Wabash	Haul to dump	None	None	.....
Iowa:				
Cedar Rapids	Haul to dump	None	None	.....
Charles City	Taken to dump	None	None	.....
Des Moines	Sent to dump	.....	.....	.....
Keokuk	Hauled to dump by contractor	None	None	.....
Ottumwa	Filling	None	.....	.....
Kansas:				
Iola	Taken to dump	None	None	.....
Pratt	Fill low places	None	None	.....
Kentucky:				
Ft. Thomas	Use for fill	Collect by motor trucks	.....	Large mileage and scattered population
Louisville	Dump on river front	None	Building incinerators	.....
Mayfield	Fill outside city	One horse wagon added	Discuss'g disposal plant	.....
Maine:				
Bangor	Local dumps	Truck for collecting	.....	.....
Rockland	Making land for public landing	None	None	.....
Massachusetts:				
Adams	Dumped	.....	.....	.....
Brockton	Dumped	None	None	.....
Cambridge	Open dump	None	None	.....
Concord	Haul to dump	Do not collect	.....	.....
Gardner	City dump	None	None	.....
Haverhill	Haul to dumps	.....	.....	.....
Hudson	Farmers remove	None	.....	.....
Natick	Gravel pit, burned when possible	None	None	.....
Northbridge	Dump	None	None	.....
Orange	Dump	.....	.....	.....
Reading	Dump	.....	.....	.....
Michigan:				
Alma	Fill at city dump	Contracted	None	.....
Ann Arbor	Fill low lots	None	Question	Contractor does not remove garbage satisfactorily (he feeds to pigs). Incinerator not used because of high price of coal
Flint	City dumps	None	None	.....
Grand Rapids	Dumps on low ground	None	None	.....
Highland Park	Hauled to dump	From incinerator to hog feeding	None	Cheaper and shorter haul
Holland	Part used in parks, poorest dumped	.....	.....	.....
Manistique	Filling new park	None	None	.....
Muskegon	Dump	None	Incinerator	Nuisance
Pontiac	Filling	None (hog farm)	.....	.....
Port Huron	Dumped	None	Not immediately	.....
Minnesota:				
Chisholm	In incinerator	None	None	.....
Cloquet	Hauled to dump	None	.....	.....
Hibbing	Garbage dump	.....	.....	.....
Rochester	Fill low ground	None (fed to hogs)	None	.....
St. Paul	City dumps	Now installing 2 tractors and 12 trailers for collection in part of city	.....	Too long haul to garbage dumps
Willmar	Dumps	None	None	.....
Missouri:				
Jefferson City	Dumped in river	.....	.....	.....
Kansas City	Fill low places	None	Build disposal plant	Economy and sanitation
Marshall	City dumps	None	Not decided	.....
St. Charles	Public dump	None	None	.....
St. Joseph	City dump	Franchise granted one company	None	.....
Sedalia	Private dump outside city	None	None	.....
Montana:				
Bozeman	City dump	None	None	.....
Lewistown	Fill low ground in city	None	None	.....
Livingston	City dump	None	None	.....
Nebraska:				
Lincoln	Filling low places, and dumps	.....	.....	.....
Norfolk	Filling low areas	None	.....	.....
Scotts Bluff	City dump	.....	.....	.....
New Hampshire:				
Nashua	Cover for ash dumps	.....	None	.....
New Jersey:				
Asbury Park	Vacant low lands	None	None definitely	.....
Irvington	Fill in low lands	None	Constn. of incinerator	Growth of town elliminates dumping places
Salem	Fill on outskirts of city	Do not collect	.....	.....
Westfield	Fill unoccupied low spots	None	None	.....
New Mexico:				
Albuquerque	Build dike along river	None	None	.....
New York:				
Endicott	Ash and garbage dump	None	None	.....
Gloversville	Dump	None	None	.....
Johnson City	Dump	.....	.....	.....
Kingston	Dumps	None	None	.....
Norwich	Dump in abandoned river channel	None	None	.....
Tonawanda	Public dump	None	None	.....

DISPOSAL OF STREET SWEEPINGS AND GARBAGE

City	Disposal of Street Sweepings	Change in Disposal of Garbage This Year	New Method Contemplated	Reason for Making Change
North Carolina:				
Gastonia	Fertilizer	More equipment	Increase efficiency	.....
Thomasville	Haul to dump	None	.....	.....
North Dakota:				
Fargo	Dump on low ground	None	Incineration	Dump becomes increasingly obnoxious as city grows
Ohio:				
Akron	Haul to dump	Fed to hogs	None	.....
Bucyrus	City dump	Patrons pay for service	None	.....
Chillicothe	Low places on outskirts	None	Install incinerator	Eliminate long and expensive hauls, abolish stench and reduce cost
Cincinnati	City dumps	Separate contract	None	Bids for removal to be advertised for during coming year
Circleville	Dump on private prop.	None	None	.....
Dayton	City dumps	None	None for a year	Plant too small
Delaware	Private lots or city dump	None	None	.....
East Youngstown	Haul to dump	None	None	.....
Findlay	Dump outside city limits	None	None	.....
Fremont	Haul to dump	None	None	.....
Lima	Dump	.....	Hope to build inciner.	.....
Mansfield	Haul to dump	Built new incinerator	.....	Additional capacity
Middletown	Vacant lots and city dump	None	None	.....
Urbana	City dump	None	None	.....
Van Wert	City dump	None	None	.....
Zanesville	Neighboring lots or public dump	Delivers to farmers at edge of city	None	.....
Oklahoma:				
Blackwell	Dumps	None	None	.....
Chickasha	Municipal dump (burning)	Contract	Incinerator	Contractors not responsible; many complaints
Enid	Low streets and alleys	Contract	None	.....
Oregon:				
Astoria	Hauled 1 mile to garbage dump	None	None at present	.....
The Dalles	Dumping ground	.....	.....	.....
Pennsylvania:				
Ashland	Borough dump	.....	.....	.....
Butler	City dump	None	None	.....
Carbondale	Dumps	None	Problematical	.....
Clairton	On low ground	None	None	.....
Clearfield	Sold as fertilizer	Have no system	None	.....
Dormont	Park fill and fertilizer	Contractor collects and feeds to hogs	None	.....
Forest City	Dump	None	None	.....
Freeland	Borough dump	None	.....	.....
Hanover	Fill low places	In old quarry 1½ mi. from town	None	.....
Lancaster	Public dump	None (Incinerator not used—Coal too dear)	.....	.....
Meadville	Fill	None	None	.....
Munhall	Refuse dump	None	.....	.....
Norristown	Public dump	Contract for $9,000; fed to hogs 5 mi. from city	None	.....
Philadelphia	Dumps	Now building incinerator for part of city	.....	To dispose of garbage collected at excessive distance from reduction plant
Rankin	Haul to dump	None	None	.....
Steelton	Garbage dump	None	None at present	.....
Swoyerville	Fill low land	None	None	.....
West Pittston	Dumped	None	None	.....
Woodlawn	Refuse dump	None	None	.....
Rhode Island:				
Pawtucket	Public dump	None	None	.....
Woonsocket	Dump	None	None at present	.....
South Carolina:				
Chester	Dumped on farm	None	None	.....
Orangeburg	Fill low bottom lands	None	.....	.....
South Dakota:				
Lead	Haul to dump	None	None	.....
Rapid City	Fill low places	None	.....	.....
Tennessee:				
Jackson	Haul to dump and incinerator	None	None	.....
Kingsport	City dump	.....	.....	.....
Murfreesboro	Dump	None	None	.....
Texas				
Amarillo	Dump grounds and isolated holes	20-ton incinerator inst.	None	.....
Burkburnett	Haul to dump	None	City control garbage wagons	Give better service to residential sections
Childress	Canyon dump	.....	Incinerator	.....
Del Rio	Dump	None	.....	.....
Eastland	Buried	None	None	.....
San Angelo	Dump	None	None	.....
Vermont				
Brattleboro	Dump in river	None	None	.....
Rutland	City dump	None	None	.....
Virginia				
Danville	Used with manure in parks and cemeteries	None	Hope to	.....
Fredericksburg	City dump	None	None	.....
Harrisonburg	City dump	.....	.....	.....
Newport News	Dump on low ground	None	None	.....
Richmond	Dumps	None	Must install plant within 3 years	.....
Staunton	Sold for fertilizer	None	None	.....
Washington				
Aberdeen	Haul to low lands	None	None	.....
Walla Walla	City dump	.....	.....	.....
West Virginia				
Clarksburg	Dump on waste land	None	None	.....
Fairmont	Haul to nearest dump	None	Possibly incinerator in 1924	Burning garbage on open dump very objectionable
Wisconsin				

Economics of Highway Grades

Under the above title a bulletin has been published by the Engineering Experiment Station at Ames, Iowa, having been prepared by T. R. Agg, highway engineer of the Experiment Station, to present, in the nature of a progress report, tentative conclusions from experiments that are still being continued.

In 1919 this experiment station began an investigation of the economics of grades for highways based on motor-drawn rather than horse-drawn traffic and several years will be required to evaluate all the factors that enter into the problem. The investigation was carried out by Mr. Agg, assisted part of the time by Prof. W. L. Foster of the Civil Engineering Department; while the Iowa Highway Commission cooperated by loaning trucks and small equipment. The vehicles used in the test were a 1.85-ton Buick with pneumatic tires, a 4.14-ton light aviation army truck with Goodyear cord tires, and a 7-ton heavy aviation army truck with solid front and dual solid rear tires.

An analysis of the problem from the purely theoretical standpoint, considering only fuel consumption and speed of motor vehicles, indicated that the three factors controlling the economical maximum grades for motor vehicles are: length of grade, resistance to translation on the particular road surface, and maximum tractive effort of the vehicle. To study the relation between these, records were desired of fuel consumption and other pertinent data for vehicles operating under normal conditions on hilly roads. Special appliances were devised for measuring minute amounts of gasoline consumption, that adopted having as its essential feature a piezometer ring, the velocity head at which is measured by a calibrated diaphragm.

A number of runs were made with the different vehicles over different grades and at different speeds and the results obtained as to fuel consumption were plotted. A study of the diagrams indicates that, if fuel consumption only be considered, the most economical highway grade for descending traffic is that rate of grade that will permit the vehicle to descend without obtaining an unsafe speed and without the use of a brake; the economical maximum rate of grade for ascending traffic is that which will permit the vehicle to ascend without changing gears and at a speed that permits the motor to operate most efficiently; and this maximum will depend upon the resistance to translation of the vehicle, the length of the grade, the allowable limits of speed and the tractive power of the vehicle.

The bulletin considers these points from a theoretical point of view and develops formulas for comparing per cent of grade, length of grade, resistance to translation and speed of vehicle; also formulas for allowable expenditure for reducing grades. Finally, the conclusions to date are summed up as follows:

"In the foregoing discussion there is presented a tentative economic theory of highway grades. The value of the deductions depends upon the sufficiency of the experimental data and the accuracy of the assumptions relative to the characteristics of the composite vehicles. There has been analyzed a great mass of data bearing on the subject and extensive field investigations have been in progress for 3 years, but the subject involves so many variables that the results presented herein can hardly be considered more than the first step in the establishment of an adequate theory of highway grades. Amplifications and refinements to the theory will be made by those interested as rapidly as pertinent experimental data are available.

"If the principles presented herein are considered in connection with trunk-line highways, where the annual traffic may reach several million tons, it will be apparent that the actual value of the fuel saved by grade reduction may reach very significant sums.

"That value of lost time due to excessive grades is an even larger sum, where the volume of commercial vehicle traffic is large, and undoubtedly a similar loss accrues to a considerable percentage of the automobile traffic. It is highly important to establish a basis for evaluating lost time, but it is one of those elusive quantities which are difficult to analyze.

"It seems to have been established that momentum grades on rural highways are economical both from the standpoint of fuel and time and that, under certain circumstances, less fuel will be required on a road with an undulating grade line than on one with very flat grades. It is also shown that no economy results from the reduction of long grades of less than 3 per cent and that short grades may reach 8 per cent without adversely affecting either fuel consumption or average speed.

"Fuel cost is an item amounting to only 15 or 20 per cent of the cost of operation of a motor vehicle, but a saving of one-tenth of the fuel annually consumed in a state will amount to a large sum.

"Almost invariably those things that lower fuel consumption also lower maintenance costs for the vehicle and thus indirectly effect a saving in repair bills and tire wear, which is considerably larger than fuel saving.

"One interesting fact brought out in the fuel consumption runs was the marked saving in fuel that results from coasting down hill with the motor declutched. This is a perfectly feasible way to drive an automobile but may be dangerous with a commercial vehicle. It should not be practiced with any kind of vehicle on long grades or where safety considerations require the vehicle to be kept under control.

"Safety, aesthetics and drainage considerations in connection with grade reduction are outside the scope of this investigation, although they are factors that must always be considered in connection with highway improvement."

Justification of Highway Expenditures

The Department of Highways and Public Works of Tennessee, of which J. G. Creveling, Jr., is Commissioner; C. N. Bass, First Assistant State Highway Engineer and R. H. Baker Second Assistant State Highway Engineer, is urging a construction program of eighty-six million dollars, and in justification of this sum presents the following calcula-

tion of the value of the service that such expenditure would make available.

"The highways of Tennessee are serving a real transportation need. More improved highways will increase the annual service and decrease the present cost of transportation. To August 1, 1923, there were registered 151,718 autos and trucks, 134,316 autos, and 17,402 trucks. Traffic studies show that these vehicles travel annually at least 2,000 miles each on the public roads. Each auto carries on the average 2.2 passengers, and each truck carries an average of two tons. The transportation service is therefore:

134,316x2,000x2.2—590,990,000 passenger miles
17,402x2,000x1.0— 54,800,000 ton miles
(*Trucks travel one way empty*)

"Assuming a fair charge for this service to be 1 cent per passenger mile and 2 cents per ton mile, the annual value of the service would be approximately $7,000,000. During the next five years the above registration will increase 50 per cent, making the service to correspondingly increase, or making the annual service $10,500,000.

"Subtracting the annual needs for maintenance, depreciation, and management, there would remain $6,150,000 annually, which capitalized at 5 per cent, would justify a construction program of $123,000,000.

"It is thus seen that a construction program of $86,000,000 is more than justified, leaving nearly forty million dollars to improve additional highways of the state."

The department emphasizes the importance of maintenance, and of considering the cost of this in selecting type of road. It makes the folowing comparison of annual cost of fine types or roads. The authority for or source of the figures is not named.

ITEM	Ordinary Gravel	New Carpet Treated Macadam	Penetration Macadam	Cement Concrete	Earth
First Cost Per Mile.	$5,000	$18,000	$22,000	$33,000	$1,000
Life of Surface	5	10	10	20	indef.
Annual Int. at 5%...	250	900	1,100	1,650	50
Maintenance	300	750	550	230	250
Cost of Resurfacing.	2,500	9,000	11,000	23,000	None
Annual Sinking Fund	466	767	852	814	None
Annual Cost.....	$1,016	$ 2,417	$2 502	$ 2,694	$ 300

It is seen that on this basis cement concrete is the most expensive and earth the least. No reference is made to the kind or amount of traffic that can be carried on an earth road indefinitely without ever resurfacing and with an annual maintenance cost of $250 a mile; nor to that which can be carried on a carpet-treated macadam for ten years, or half as long as a concrete road will last.

State Construction of Roads

The State Highway Department of Michigan has decided to build its roads by force account rather than by contract and one result of this is brought to our attention by a letter from one of our subscribers who is a contractor in that state. He states that he has confined his work largely to concrete road building and "with the state doing all the roadwork we do not see that there is anything left for us to do except to endeavor to dispose of our equipment and liquidate."

Selection of Pumping Equipment*

Securing maximum station economy in choice of class of pumping equipment for supplementing existing plant.

The author discussed this subject in connection with the problem of selecting a pumping unit to meet increased demand upon an existing plant. In comparing the various types the author based his figures on units of about 3,000,000 gallons per day capacity, as the majority of pumping plants in New England are of that size or smaller. He also assumed that the existing plant is a steam operated one having a good boiler equipment.

CRANK AND FLYWHEEL

The crank and flywheel pumping engine is without question the most economical in the use of steam, being able to deliver about 124,000,000 foot-pounds per thousand pounds of steam under the ordinary steam conditions found in existing pumping stations. This class of engine also has an excellent record for dependability and low cost of upkeep. The cost is higher than that of other types, but even with the high cost this type is a favorite where maximum steam economy is the main consideration.

Where the capacity of a steam plant has been reached and the type is obsolete, such as direct-acting compound pumps, a crank and flywheel engine should receive serious consideration if there is available space for it; but if installing such an engine would entail an expensive addition to the building the resulting fixed charges might be greater than would be warranted even by the high duty of the plant.

TURBINE DRIVE

The turbine driven centrifugal pump has the advantage of low first cost and very small space requirements as compared with the crank and flywheel engine. It will give, however, a duty of only 100,000,000 foot-pounds. An additional advantage is the very small foundation needed and the ease of arranging suction and discharge pipes.

*Abstract of paper by Frank A. Mazzur before the New England Waterworks Association.

If the problem is that of a plant which already contains an economical pumping engine for regular service but for which a new standby unit is desired, a steam turbine driven centrifugal pump offers the best solution, for it requires no more space than a direct-acting duplex pump of considerably less capacity, the price is as low as that of any dependable pumping equipment, and even if operated for long periods the operating cost would not be very much above that of the most economical type of steam pump.

ELECTRIC DRIVE

Where the boiler plant and all the steam machinery is in good condition, economy is seldom obtainable by changing to electric drive, especially in a plant of such size as to require only one man on duty for a steam plant, since one man would be required for an electric plant also, although there might be some saving in the possibility of using one who is not a licensed engineer.

An electrically driven pump may be either a plunger pump geared to an electric motor, or a centrifugal pump direct-connected to the driving motor. The plunger pump would be practically the same unit employed in connection with a crank and flywheel engine, while the direct-connected centrifugal pump would be the same as the one driven by the geared steam turbine. As in the case of comparing crank and flywheel and turbine driven pumps, the problem is simply one of fixed charges and operating costs. The guaranteed pump efficiency of the horizontal plunger type pump of this size is about 90 per cent. and that of the centrifugal pump about 80 per cent., and the operating costs of the two are surprisingly similar when both fixed charges and cost of current are considered.

In considering the installation of electrically driven apparatus it is very important to bear in mind the possibility of interruption of service, and where such interruption is possible, it is advisable to provide an additional drive of either oil or gasoline engine.

OIL ENGINE DRIVE

During the war great advances were made in the design of Diesel type oil engines and today they may be classed as prime movers that have demonstrated their value from the standpoint of both economy and dependability, and the author believes that this engine must be seriously considered by those aiming to operate their plants at the highest possible economy. A Diesel oil engine geared to a horizontal plunger pump of the size under consideration can give a duty far greater than the largest and most refined type of steam driven pumping unit that has ever been built. An oil engine driven unit of 3,000,000 gallons capacity can operate on a cost for oil equivalent to a duty of at least 225,000,000 foot-pounds per 1,000 pounds of steam. Moreover, with the oil engine, the efficiency of comparatively small units is almost as great as that of very large units, and this feature is making the Diesel oil engine a very attractive proposition for waterworks pumping installations of small and medium size.

COMPARISON OF OPERATION COSTS

The author presented a table giving a comparison of operation costs of the various types of pumping equipment considered. In compiling this table he eliminated all items of operating cost that would be practically the same no matter what type of unit might be installed, and considered only the fixed charges of interest and depreciation, and the cost of fuel or current.

The interest and depreciation he has taken as 12% on the crank and flywheel engine and 15% on all the others. Coal is taken at $8.50 a ton and current at the charges made by the Boston Edison Company, which are 2c per k.w. on the basis of an 8-hour day, 1.7c on the basis of a 16-hour day and 1.64c on a basis of a 24-hour day. Current in other places will probably cost

COMPARISON OF OPERATION COSTS OF VARIOUS TYPES OF PUMPING EQUIPMENT, CAPACITY 3,000,000 GALLONS IN 24 HOURS, INSTALLED AS ADDITION TO EXISTING STEAM PLANT.

	Steam Driven		Electrically Driven		Oil Engine Driven
	Crank and Fly Wheel Plunger Pump	Turb. Driven Centrifugal Pump	Horizontal Plunger Pump	Centrifugal Pump	Horizontal Plunger Pump
Cost of unit installed with appurtenances and necessary change to building	$33,000.00	$15,000.00	$17,500.00	$10,000.00	$31,000.00
On Basis of Pumping Eight Hours Per Day.					
Interest and depreciation	$3,960.00	$2,250.00	$2,530.00	$1,500.00	$4,650.00
Cost of fuel or current	2,660.00	3,480.00	6,170.00	6,870.00	1,450.00
Cost of banking fires for 16 hours	$20.00	$20.00	.....	.....	.....
Cost of coal for heating	.....	.....	200.00	200.00	100.00
	$7,440.00	$6,550.00	$8,900.00	$8,570.00	$6,200.00
On Basis of Pumping Sixteen Hours Per Day.					
Interest and depreciation	$3,960.00	$2,250.00	$2,530.00	$1,500.00	$4,650.00
Cost of fuel or current	5,330.00	6,950.00	11,010.00	12,100.00	2,900.00
Cost of banking fires for 8 hours	410.00	410.00	.....	.....	.....
Cost of coal for heating	.....	.....	200.00	200.00	100.00
	$9,700.00	$9,610.00	$13,740.00	$13,800.00	$7,650.00
On Basis of Pumping Twenty-four Hours Per Day.					
Interest and depreciation	$3,960.00	$2,250.00	$2,530.00	$1,500.00	$4,650.00
Cost of fuel or current	7,990.00	10,400.00	15,700.00	17,250.00	4,350.00
Cost of banking fires	.....	.....	.....	.....	.....
Cost of coal for heating	.....	.....	200.00	200.00	.....
	$11,950.00	$12,650.00	$18,430.00	$18,950.00	$9,000.00

more than this rather than less, although somewhat lower rates may be obtained in localities adjacent to large water power. Steam and oil consumption was based on guarantees of the manufacturers.

If the plant has a large reservoir capacity, 8 hours pumping per day will usually suffice. With ample standpipe and small night consumption, two shifts may be possible; while where the pumping is against direct pressure, full 24-hour operation is necessary. The tabulation referred to is divided into three parts, one on the basis of pumping 8 hours a day, the second pumping 16 hours and the third 24 hours. The results naturally differ. It will be noticed that in this case the capacity of the pump is the same in each case and consequently the amount of water pumped per day will be twice as much in the second case as in the first and three times as much in the third case.

On the basis of an 8-hour day the oil engine driven pump is seen to have little advantage over the turbine driven centrifugal, because of the higher first cost; but where pumping is continued more than 8 hours, the economy of the oil engine driven is correspondingly increased because of the low fuel cost. In the 8-hour pumping the centrifugal pump is seen to have a slight advantage over the horizontal plunger, while the relative position of these two is reversed for the longer pumping days.

Where steam driven pumps only are considered, the crank and flywheel pump seems to be slightly less economical for the 8-hour and 16-hour day, but more so for the 24-hour period. The difference, however, is so slight that other considerations might readily control the choice. For instance, if money for purchasing the more expensive pump were readily obtainable, the other advantages of the crank and flywheel pump might decide a water board to purchase it, while the choice might be for the much cheaper centrifugal pump if money had to be borrowed.

In the case of the 8-hour day, the advantage in economy of the oil driven engine is so slight that it would not seem advisable to change to oil if the steam plant was in good condition and the operating force trained in handling it.

Considering the 16-hour day, the crank and flywheel engine would be chosen in preference to the turbine driven centrifugal because of its long life and reliability. Electrically driven pumps would apparently be out of the question in this case because of the high operating cost. The economy of the oil engine is considerably greater than of the steam driven pump in this case and installing it even in the steam operated plant would be seriously considered.

For the 36-hour pumping day, the electrically driven engine is apparently out of the question, while on the other hand the oil driven engine increases its lead over the steam driven.

The author states that in preparing this tabulation he used for the crank and flywheel pumping engine, the turbine driven pump and the electrically driven centrifugal pump, costs of installations actually put in. Of course costs of installation will vary in different plants and those given in the table are therefore to be taken as approximate. "Each and every installation is a problem in itself, and unless viewed from every angle and every factor carefully weighed, it is very easy to make a selection that will be disappointing in the results obtained."

COMPARISON BY ANOTHER AUTHORITY

In a paper before the Detroit convention of the American Waterworks Association last spring, Arthur L. Mullergren, of Kansas City, Missouri, in a somewhat similar discussion, stated that the Diesel type of oil engine would under certain conditions make a showing better than most engineers apparently realize. While the cost of equipment is high, the fuel economy also is high, reaching a thermal efficiency of 35% and the total cost per unit of work performed might compare favorably with coal in localities where this is expensive. In general he states:

"In stations having a daily capacity of 10,000,000 gallons and above and with coal costs around $6 per ton, the high pressure steam-driven centrifugal pump will ordinarily show the best duty per dollar of annual charges over any other isolated type of plant. In plants below this capacity, each particular installation would require thorough investigation and careful balancing of all costs, before a definite type of plant could be decided upon. It is generally recognized that, in plants of 3,000,000 to 5,000,000 gallons daily capacity, the cross-compound flywheel pumping engine will make the most favorable showing. In regard to thermal efficiency this may be true, but it would not hold in every case if the duty per dollar of annual charges were considered."

Concerning the reliability of service of an electrically-operated pumping plant, the same author stated that "with the duplicate or loop transmission lines and interconnected central stations, practically as great a reliability as in the self-contained plant will be secured."

Use of Street-Cleaning Devices

In the street-cleaning statistics collected by us a few weeks ago, and published in the October issue, nearly 200 cities gave information concerning the appliances used by them in cleaning streets and the relative areas on which the different kinds were employed. An effort is made below to summarize the information as to kinds of appliances used. There does not seem to be any practicable method of presenting summaries of the other information.

In quite a number of cities two or more kinds of appliances are used on the same area, either co-operating in the cleaning or used alternately. For instance, hand brooms are commonly used

for sweeping into piles along the gutter the dirt that is washed into the gutter by street flushers. In the same way hand brooms are used for sweeping into piles the windrows of dirt thrown up by machine brooms. In business streets the flushing machine may be used at night, while hand brooms are used by white wings during the daytime to maintain the street continuously as clean as is possible by that method. In some cities or districts hand brooms are the only method of cleaning employed; in others pick-up sweeping machines are used exclusively. To a considerable extent the practice in this regard in the different cities is indicated in the tables already referred to.

The appliance used by the greatest number of cities is the hand broom, 148 cities reporting using these, and 30 reporting not using them. Machine brooms are used by 38 cities, pick-up sweepers by 33 cities, flushing machines by 68 cities, and hand flushing by hose in 34 cities. In the matter of hose flushing, however, several cities report using this only occasionally rather than as a routine practice.

In reply to the question as to the use of machine sweepers and flushers by day or by night, 9 report machine sweeping by day, 43 by night, 2 both day and night and 7 in the early morning. Flushing is performed in the day by 19 cities, at night by 42, both day and night by 20 and in the early morning by 5. While approximately the same number use machine sweepers by night as use flushers, the number of the former used by day is less than half the latter. Probably the explanation of this is that the flusher can work more effectively than can the machine sweepers when the curbs are lined with teams, as they are apt to be in the business section during most of the day.

In the same table are given some data concerning snow removal and from this we learn that of 179 cities reporting on this question, 121 remove snow from a greater or less area of streets. The area so cleaned is usually the "business district," "principal streets," "paved streets," etc. A number of the cities remove the snow only occasionally, while others apparently make it a regular practice when the snow is at all deep. Of course, the 58 that report never removing snow include a number in the Southern States where snow seldom if ever falls.

FLUSHING STREETS

It seems to be generally believed and frequently stated that the most sanitary method of cleaning streets and the only one for thoroughly removing all dirt is that of flushing. Of about 180 cities, large and small, reporting to us the methods used by them of cleaning streets, 71 reported using flushing machines. On the other hand, however, three reported having discontinued the use of flushers, and several have greatly reduced the amount of use of them. The reasons for this were explained as follows:

"Kansas City, like a great many other cities, is short of money to carry on city business and it was economy to discontinue the use of these horse-drawn flushing machines. However, the superintendent of street cleaning says that when the department is in better financial condition he will go back to the use of these machines, as they are a great help in keeping the down-town streets clean. He also expects to ask the administration for power-drawn machines, as he believes they are of greater service than the horse-drawn vehicles, on account of our numerous street grades."

In Norristown, Penn., flushing was discontinued "for two reasons: first, the expense; second, the fact that our machine was one of the ——— flushers and produced such a powerful stream as to cause the cement in our pavements to be dislodged and the joints opened. This is also true of the joints on our Belgian block pavements, wherein tar and gravel had been used. . . . The cost of water was nil, as we are given all the water necessary for street flushing by the water company, so that was not an item of expense."

Flushing was discontinued in Chillicothe, Ohio, because "it does harm in that the continual use of same has a tendency to wash a great portion of the filler from between the bricks, leaving the same exposed, so that they are soon exposed to such an extent as to be chipped off and broken by heavy traffic. Also, there is so much water required and the dirt, at least about 80 per cent. of it, is so light that when forced to the gutter it will float down into the catch basins and will then have to be handled the second time and at a greater cost than gathering it direct with the sweeping machine, which not only cleans but also hauls the dirt with one operation. There is no question but that flushing will wash the dirt off better, but the cost of upkeep of the streets and the other unnecessary expense mentioned above should be seriously considered."

This subject was discussed at the convention last year of the International Association of Street Sanitation Officials. W. J. Galligan of Chicago said that flushing is invaluable in Chicago, one of the principal reasons being the smoke from locomotives and dust from coal and sand yards, all of which settles upon the pavement and can be thoroughly removed only by flushing. Chicago had purchased ten new street flushers last year, and intended purchasing ten each succeeding year until it had fifty. He stated that he preferred the double unit to the single unit. F. D. Furlong, of Minneapolis, said that he did not favor flushing as strongly as he used to, and that they did only half as much flushing as formerly and expected to do even less in the future. O. P. Mahoney of Joplin, Mo., said that his city had discontinued flushing altogether. B. C. Harvey of Rockford, Ill., thought it essential to flush all paved streets two or three times a week, no matter how frequently or well the street was swept.

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Experience as a Basis of Imhoff Tank Design

Owing chiefly to the fact that the engineers who design sewage treatment plants very seldom operate them, and that, on the other hand, plant operators seldom design new plants, probably most of the plans for such plants that have been prepared have been based largely upon theoretical considerations rather than upon a thorough scientific analysis of the results obtained in operating similar equipment; while existing opportunities for obtaining knowledge of operating conditions, phenomena and results are too seldom taken advantage of, and therefore fail to be available as a basis for future design.

This condition gives added importance to the article in this issue by Mr. Downes, giving his analysis of the results obtained with Imhoff tanks in the plant under his charge and others, and his tentative conclusions therefrom and the application of such conclusions to the designing of tanks of this kind. Mr. Downes does not claim that these conclusions are other than tentative, and urges others who have opportunity to collect similar data to do so in order that facts may ultimately be available in sufficient number and variety to permit the deduction of general laws applicable to Imhoff tanks under all conditions.

There is every reason to hope that operating data will be secured much more abundantly in the future than they have been in the past, owing largely to state laws requiring the operation of plants by competent men, and advancement in the art of sewage treatment is bound to result therefrom.

Cleaning Filter Stone

In many and probably the majority of plants containing sprinkling filters or contact beds, any stone that may be removed from time to time because of excessive accumulation of solid matter is discarded and replaced with new stone as being less troublesome and, in some cases, less expensive than cleaning and returning. In sprinkling filters that are operating successfully it is, of course, seldom necessary to remove stone for this reason, but even with them occasions may occur when better results could be obtained by replacing the old stone with clean, fresh material than by waiting for the bed to purge itself of accumulated deposits.

The chief drawback to using old stone again is the difficulty and expense of cleaning. How this was done in a small plant by the use of appliances readily available is explained in an article in this issue. Owing to the considerable amount of labor attached to the work, and high wage rate, the expense was rather high; but, even so, it was estimated to be less than that of securing new broken stone to take the place of the old.

A Prompt Federal Report

We have had occasion several times during the years past to criticize the excessive and it seemed to us inexcusable delay in the issuing of reports of the Census Bureau and other Federal bureaus and departments. It gives us all the greater pleasure, therefore, to record unusual

promptness in the issuing of a federal report from the Government Printing Office. There reached this office on October 16th a report dated September 21st (and apparently the writing of the report was not completed until that date), which included 23 pages of text, 24 pages of tables, and 10 diagrams, four of the last-named being folded inserts. This is certainly remarkably quick work and especially so under conditions which we realize prevail in connection with the publication of Federal reports.

The report in question is that of the Federal Fuel Distributor, F. R. Wadleigh, to the President of the United States. The position of Federal Fuel Distributor was created by an act of September 22nd, 1922, and this report gives in detail the work performed by the distributor during the year of his term of office.

Another statement of this report which calls for commendation is that relative to the finances of the fuel distributor. The act establishing the organization authorized an appropriation of $250,000 for expenses and an appropriation was actually made of $150,000. Even this appropriation, however, was not spent, but the fuel distributor returned at the end of his term a balance of $46,459. It certainly is by no means customary for any federal bureau or department to limit its expenditure to 40 per cent. of the amount authorized.

Parking Automobiles

Almost every city engineer or other official having to do with traffic matters in cities of any size, whether large or small, is finding one of his most perplexing problems that of handling the automobile traffic, and especially the parking of automobiles in the business section. John Ihlder, manager of the Civic Development Department of the Chamber of Commerce of the United States, discussing this matter recently, called attention to this problem of regulating the automobile when standing still and considered possible remedies, especially those where foresight can prevent the spread of occurrence of this difficulty in sections not yet fully developed.

"In nearly all cities," said he, "large as well as small, there are considerable areas in the centers of blocks, even in downtown districts, now disused or wastefully or uneconomically used. So long as these block centers remain in private ownership, they are a constant temptation to the erection of deep, solid buildings, the lighting and ventilation of which is difficult and expensive. There is an economical depth, just as there is an economical height, for a store or office building. Where blocks or squares are so large that this economical depth is exceeded, the rear ends of the lots may well be thrown into one open space and used for parking. Incidentally, such a use, meeting a real need, would greatly lighten the task of those called upon to enforce those sections of a building code requiring light and ventilation, and it would maintain the rental value of rear offices which would no longer be shut in by the solid walls of a neighboring structure .....

"A number of methods are now being tried out, ranging all the way from storage buildings several stories in height equipped with automobile elevators, to the use of basements or cellars reached by ramps. Private initiative also has seized upon vacant lots and in some cases the backyards of business blocks and is using these temporarily for automobile parks. What private initiative has here begun indicates that municipal service can more adequately and systematically do. One rule to use as a guide here is that all such storage or parking spaces should have their entrances and exits—and they should have separate exit and entrance—on side streets or minor streets where the constant crossing of sidewalks by automobiles will least interfere with pedestrians."

Mr. Ihlder, however, does not believe that the use of all these methods to the utmost practicable extent will meet the demand.

The difficulty occurs not only in the business district, but also in the residential district. Here the parking is more likely to occur at night, and night parking in such districts is objected to with reason.

The truck presents an additional problem because of its size. If parked parallel to the curb, it takes up a large amount of space and is placed inconveniently for loading. If parked at an angle, it projects too far into the roadway and often on to the sidewalk as well.

Apparently Mr. Ihlder has no solution to recommend for existing business sections. He concludes, however, that it makes imperative the city planning and street designing of new sections and new cities so as to prevent to a very large extent the congestion which is now found in all of our larger cities.

Completing Contracts on Time

The Alabama State Highway Department on October 22 made public the ruling "that all contractors be and they are hereby notified that if contracts taken by them are not finished by them within the time stated by such contractors in their proposals, that all expense of all kinds incurred by the State growing out of these unfinished projects shall be paid by said contractors. This rule to be enforced on and after December 1, 1923."

Just what expenses the department had in mind we do not know, but the statement would at least include the salaries of engineers and inspectors employed in supervision of the contract. Possibly other expenses may be included, such as the upkeep of detours. It is not stated whether the clauses of the contract providing for extension of time would act to relieve the contractors of the payments of these expense. Where the delay was in no way avoidable by him, it would not seem just to charge him with them, especially in view of the fact that this delay has probably also burdened him with expenses which it was not possible for him to avoid and which he had no reason to anticipate.

Where the contractor is responsible for the delay, however, we believe that it is perfectly proper to charge these expenses against him and we believe that the courts have upheld these as legal. The writer made a practice of including a similar clause in contracts prepared by him for public works twenty years ago.

Notes on the Proper Placing of the Slots in Imhoff Tanks

By John R. Downes

Study of unprecedentedly complete data shows that a great improvement in operation may result from a small change in the distance between the slot and the hopper, effective storage space increasing much more rapidly than such distance.

A recent conference with Dr. Imhoff has brought home to me a point of view with regard to the proper placing of the slots of the Imhoff tank which, so far as available literature would indicate, seems very largely to have escaped the notice of most engineers. Dr. Imhoff was very emphatic in the statement that the mere provision of a given number of feet capacity in the digestion chamber means absolutely nothing unless such capacity is obtained by the proper proportioning of the three dimensions.

On thinking this over in connection with my own experience and with data made available by the N. J. Sewage Experiment Station, I determined to attempt to produce a graphic presentation of the facts which would throw more light on proper proportioning of the three dimensions.

The following data were at hand:

(1) A concrete example in which Dr. Imhoff had indicated a modification of an existing tank to secure additional distance between the hopper and the slot and at the same time to secure better distribution of the sludge (freshly deposited solids). See Plate II.

(2) Operating data on the tanks in question showing that digestion was very poor at first but had been greatly improved later by improving the solids distribution through manipulation in operation.

(3) Published data from various sources indicating that the best digesting tanks evolve gases in approximately the following proportions:

CO_2—10%; CH_4—85%; N—5% or less.

(4) Data furnished the Research Commission of the N. J. Sewage Works Association by the New Jersey Sewage Experiment Station, showing the proportion of different gases evolved at different stages in the digestion of sewage solids. (While the latter was confined to two tests of the same sample under different conditions, the results check with other experiences with complete and incomplete digestion.) See Plate I.

(5) Volume of solids deposited (calculated from cone glass readings), and volume of sludge accumulated in tanks over a period of years.

(6) Length of time required to digest solids to a 90%-95% sludge which can be handled without nuisance and with fair economy. (The best sludge obtainable in the tanks in question). This length of time was observed by carefully drawing all the sludge of this definite degree of digestion from all the hoppers of a tank: then putting the tank into operation for definite periods of time, repeating the drawings and making measurements. These measurements check with fair accuracy the quantity of "ripe" sludge drawn from the tanks over a period of years.

Weighing all the evidence in hand, it would appear as a logical proposition to state that: The slot of a two-story tank should be placed with due consideration of the progress of digestion which will have been attained at the time when the fresh solids (without shrinkage) would have accumulated to a depth equal to the distance between the hopper and the slot, and that the horizontal dimensions of the tank should be such that the solids shall be evenly distributed in so far as possible.

For instance, in the case cited to me by Dr. Imhoff, the original design so placed the slot that, in cold weather, digestion could not possibly have begun at the time that the accumulating solids reached the slots. In warm weather the digestion process would have arrived at the shifting point between CO_2 digestion and CH_4 digestion at the time the solids reached the slot. See Plate I.

Of course, except when putting a new plant into operation, we do not start with all fresh solids, but a little consideration will indicate that a new digestion curve (Plate IV — digestion of unit volume of solids in percentage of original volume) starts on its course each day of operation to terminate 30 days later. Meanwhile 30 other unit volumes have started to digest and a volume equal to 70% of 30 days fresh deposits is always on hand, in the transition stage.

The fact is that the tanks in question acted exactly as if there had been no contraction or digestion shrinkage, probably because what little progress in digestion had been made at the time when the solids reached the slot had simply evolved gases which buoyed up and distended the mass of solids.

In this case, while the total volume of space between slot and hopper provides for 57 days storage of the settling solids as calculated from cone glass readings, the distribution of the solids was such that they deposited to a depth of 4 inches per day (average) and to considerably greater depth at the inlet end. The average of 4 inches per day would mean that the accumulating solids would reach the slot in 18 days.

At a later date it was established that the digestion period in summer weather was 30 days.

By altering the operating program to improve the distribution of solids, the effect was gained of raising the slot to a point where the oldest solids had

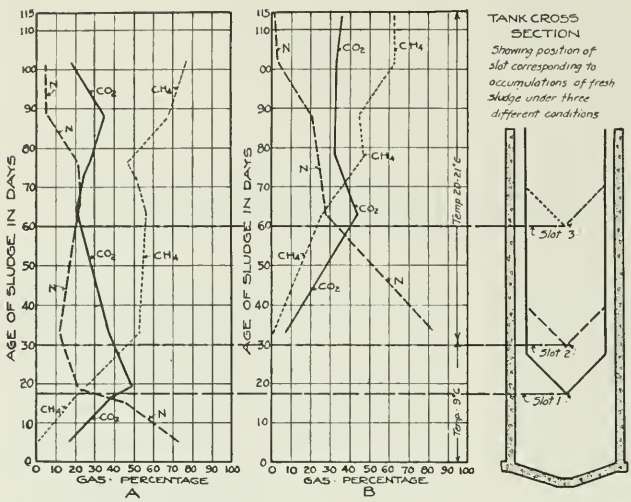


PLATE I—PROGRESS OF SLUDGE DIGESTION.

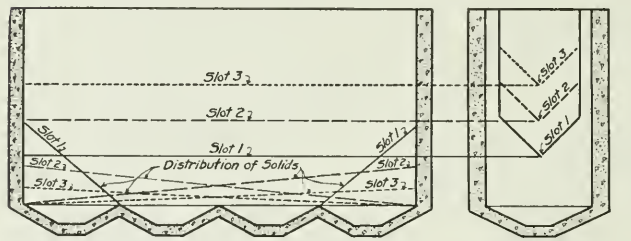


PLATE II—LONGITUDINAL SECTION THROUGH IMHOFF TANK, SHOWING DISTRIBUTION OF SOLIDS.

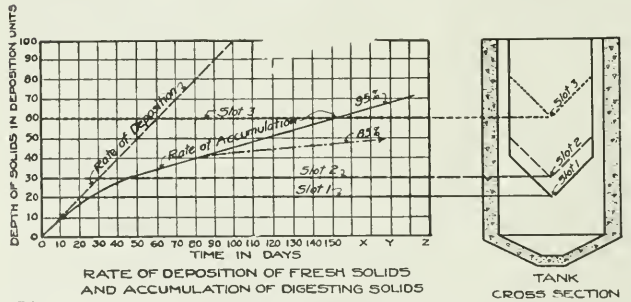


PLATE III—EFFECT ON STORAGE CAPACITY OF RAISING SLOT.

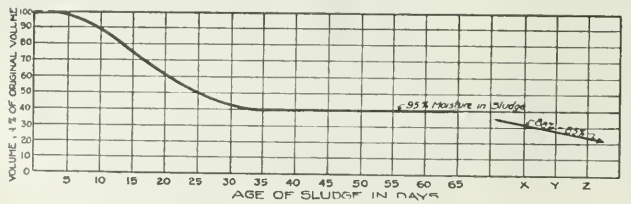


PLATE IV—SLUDGE DIGESTION CURVE.

PLATE I:

Showing progress of sludge digestion as indicated by the relative proportions of the gases evolved, CH_4, CO_2, N_2. Sample of solids collected in settling compartment of an Imhoff tank so as to represent all grades of solids proportionally; divided into two one-liter portions, and:

A—incubated at 20° to 21° C. throughout.

B—incubated at 9° to 20° C. for 31 days, during which digestion was prevented and after which it was retarded, even after the temperature had been raised to 20° C.

At the right is indicated the relative position of the slot of an Imhoff tank with reference to the progress of digestion under three different conditions. This is shown in number of days' accumulation of fresh solids required to reach the slot.

Slot 1—Position of slot as constructed and operated according to original program. Distribution of solids as indicated by solid line on longitudinal section through tank in Plate II.

Slot 2—Position of slot when a better distribution of solids had been attained through manipulation in tank operation using 50% of the tanks at one time. (For distribution of solids, see long dash line in Plate II.)

Slot 3—Position of slot in tanks altered in accordance with the suggestion of Dr. Imhoff, providing most effective distribution of solids and the use of all tanks constantly. For distribution of solids, see short dash line on longitudinal section through tank in Plate III.)

PLATE II:

Longitudinal section through Imhoff tank, showing distribution of solids.

Slot 1—Constructed and operated as designed.

Slot 2—Constructed as designed. Use of half the tanks secures effect of slot 3.

Slot 3—Reconstructed and all tanks in use; makes 100% of capacity available through better distribution.

PLATE III:

Shows effect on actual storage capacity of digestion chamber of so proportioning the three dimensions that the accumulated solids, without digestion, reach the slot elevation only after a period of time equal to that required to complete the digestion of the initial solids.

"Deposition unit" equals depth of fresh solids deposited daily, i. e., number of cubic feet of solids divided by square feet in area covered.

PLATE IV:

Curve indicating shrinkage of unit volume of fresh solids in digestion compartment of Imhoff tank. The summation of volumes of daily accumulations of solids, each decreasing in volume according to age as shown in this curve, gives the "Accumulation curve" on Plate III.

completed the 30-day digestion period before the surface of the uncontracted solids reached the slot elevation. The improvement in operating results was very marked. See Plate III.

It is very interesting to note that this 30-day period corresponds, on the one hand, to the observed time of digestion under operating conditions, and on the other to the attainment of maximum production of CH_4 (in proportion to the other gases). See Plate I. The effect was that of moving the slot from the point where the production of CO_2 is reaching its maximum and is equal to the N production, to a point where CO_2 and N production have receded sharply and CH_4 and CO_2 are turning to an approximately parallel course.

From the point where the 30-day digestion period is past, we may look for a real reduction in volume of solids. The first day's quota of solids has now been reduced to 40% of the original volume and successive portions to points between 40% and 100% of the original. Possibly a straight line between 100 at the end of the fifth day and 40 at the end of the 30th day, following in a general way the line for percentage of CH_4, will represent the progress of digestion. Accepting the above proposition for trial, we find that we have 70% of the month's accumulation of solids still on hand in various stages of decomposition at the end of the month.

Now assume the change suggested by Dr. Imhoff to have been made. This, in effect, raises the slot up to the level which would be reached by 60 days deposits of uncontracted solids. At the end of 60 days the first 30 days accumulation of solids has all been reduced to 40% of its original volume and the second 30 days accumulation to 70% of the original volume, so that the actual elevation of the sludge is at a point equal to but 33 days accumulation of uncontracted solids, and one-half of the original deposits are fit to be drawn as sludge. This latter portion now equals 36% of the accumulation in the tank.

It will be noted that nitrogen production in experimental digestion falls rather sharply to a minimum of 5% or less about the 90th day. This possibly means that the true end of digestion is approaching, as compared with the point on the 30th day where digestion had progressed sufficiently so that sludge could be drawn and handled with fair economy and without nuisance.

If, now, instead of drawing the ripe sludge at the 60th day we take advantage of the shrinkage of 60 days deposits to the volume of 33 days deposits, to continue digestion toward a point where the N fades out and digestion is assumed to be nearing completion, we have but to follow the accumulation line in Plate III to find that we may continue on for 150 days.

Our calculations have been based on our actual experience with a "ripe" sludge of 90% to 95% moisture content. Imhoff pointed out that in satisfactory tanks this moisture content would be reduced to, say, 85% resulting in a further reduction in volume of space occupied. However, this fact does not permit of restricting the digestion space on the basis of 85% sludge, for the simple reason that such sludge is to be obtained only after a comparatively long lapse of time. At present we have no definite information concerning the length of this period of time, but we do know that it is more than 60 days, probably more than 90. In plate IV it is indicated that a further reduction in volume will occur in an unknown period of time X, Y or Z. The course of the accumulation curve in plate III would be altered in the general direction of the dot and dash line terminating in the arrow.

Another effect of providing ample storage space as outlined will be that more sludge (beyond the 30-day digestion age but still actively evolving gases) will be stored per unit of surface area, thus concentrating gas evolution, so that large bubbles of gas capable of causing a stiring action will be produced as compared with the minute bubbles which merely serve to hold all the solids in a state of quiet suspension. Any mechanical agitation releases the solids from the minute gas bubbles, the solids separating by gravity. Such mechanical agitation would be produced by rapid ebullition of gas in large bubbles such as are obtained in the very successful plants at Rochester, N. Y. The alteration suggested increases depth of such sludge from zero to 30 deposition units.

There will occur to the mind many ramifications of the problem, the discussion of which would make this article endless. Enough has been shown to indicate the importance of ample distance between slot and hopper. To give a practical illustration of the importance of this feature we may refer to the case cited by Dr. Imhoff. In this case in the original design, 6 feet was allowed between hopper and slot and this space was filled in 18 days. By adding only 4 feet to this height so as to raise the slot above what we may call the transition zone, we change the effective storage space to 150 days, as shown in Plate III (considering only the known facts with regard to 90%-95% moisture sludge).

This is, perhaps, the first time that so complete a set of data has been available for making these calculations. I have sought not to burden the text with statistics, relying rather on the graphic presentation of the facts to establish the reasonableness of the proposition and to make clear what a great difference in operation a seemingly small difference in distance between slot and hopper may make.

The "reasonableness" of the proposition is spoken of because of the realization of the fact that there is no proof other than by trying it out in the case of various tanks. This is not a one-man job and these notes are therefore made public for the purpose of promoting discussion, with full confidence that their consideration can not possibly affect design other than in the right direction.

Joint Water Supply for North Jersey

Eight municipalities of the northern part of New Jersey have asked recently to be permitted to join Newark in the development and use of the Wanague supply, the dam and tunnel for which are under construction. This will consume the entire estimated yield of 100,000,000 gallons a day.

The Sludge Problem*

What has been done recently toward solving the sewage sludge problem, especially at Milwaukee, Chicago, Baltimore, Rochester and Houston

MILWAUKEE SEWERAGE COMMISSION

Mr. T. Chalkley Hatton gives the following notes on the Milwaukee work:

The Milwaukee Sewerage Commission appointed a Fellow to the Agricultural College of the University of Wisconsin who has devoted his entire time to the use of sludge in agriculture. Intensive studies have been made of the values of activated sludge in comparison with commercial fertilizers of different mixtures. Plantings were made of corn, soy beans, Sudan grass, tobacco and other crops at the experimental farms of the University of Wisconsin, at Marshfield, Hancock, Codington, Madison and Wauwatosa. To determine the value for grass in golf greens, tests are being made at the Blue Mound, Ozaukee, Lynx and Tripoli Golf Clubs, and the Milwaukee Country Club and the Pine Bluff Country Club. A large number of pot cultures have also been made at the greenhouses of the University of Wisconsin.

The National Fertilizer Association has also been advised of the possible value of activated sludge. Samples have been sent various fertilizer distributors for investigation. The cooperation of the Executive Committee of the Association has been assured in handling and marketing the prepared sludge should it prove as satisfactory as appearances indicate.

SANITARY DISTRICT OF CHICAGO

The Sanitary District of Chicago has interested a number of agricultural experiment stations in growing tests. Work is under way on cotton in Mississippi, and on garden plants at the University of Illinois. In the Chicago territory sludge has been distributed to peony and rose growers, truck farmers, cabbage growers and to various individuals. The Lincoln Park, West Side and South Park organizations are trying sludge on lawns and grass plots.

The District has operated a test plot during the growing season, planting corn, beets and beans, with various combinations of fertilizer. Some 45 plots, each 1,100 sq. ft. in area were planted. The land, while formerly used for truck gardening had lain idle for over four years. The results in general have been encouraging. A record of weights is being kept, as the vegetables are picked, which will furnish a criterion of the real relative production.

In addition, the District has used sludge in seeding grass, in comparison with sheep manure.

The best price obtained during the year on the sale of carload lots was $9.00 per ton f. o. b. cars for sludge, dried and bagged.

BALTIMORE

Mr. Milton J. Ruark, Division Engineer of Sewers, gives the following notes of interest with reference to the sludge handling problem of Baltimore: During the year 1922, the total production of sludge was about 5,400 tons on a dry basis. This is the greatest rate of production in any year since 1918, when the output was somewhat greater. During the year 1922, about 5,500 tons on a dry basis was handled, a portion of this being heat dried sludge from the drying plant and the remainder air dried sludge taken by local farmers. For more than a year no charge has been made for air dried sludge. This season farmers have taken the sludge as often as it is produced by the sand beds, so that the drying plant has not been operated for several months.

At the present time, no income is being realized from the sale of sludge. The city has provided means to load the farmers' trucks from a trestle by dump cars direct from the sand beds, or by a derrick from the storage pile. As a rule the farmer arranges to handle sludge only when the city is operating one of the loading devices. Occasionally a farmer loads his own truck. The sludge is all used within a radius of about 4 miles, whenever possible, the farmers hauling it directly to the field, where it is spread and plowed under. Sometimes it is placed in piles or composted with manure for spreading on the fields at a later date. The farming community served is almost entirely composed of truck farmers. The sludge is therefore used to a large extent for such plants as cabbage, spinach, potatoes, stringbeans and tomatoes. It is used to some extent on corn, and to a very limited extent on grass. The amount of horse and cow manure available has decreased markedly in the last few years with the result that its cost has reached a point where farmers are seeking other materials for fertilizer. While it is evident that the farmers in the vicinity of the Baltimore plant believe the sludge is worth the handling, the city officials have desired to satisfy themselves of the real value of the sludge in agriculture. In cooperation with the Agriculture Experiment Station of Baltimore, a series of experiments have been outlined to extend over some 4 or 5 years. Nine acres have been laid out in 6 sections of 1½ acres each, each section being divided into 6 plots of ¼ acre each. The whole of each section has been treated with one of the following fertilizers: Liquid digested sludge, air dried sand bed sludge, commercial fertilizer, commercial fertilizer and dry sludge and manure. As a control, one plot has been given no treatment. One-half of each section then was treated with lime in a manner to cover half of each plot. In one plot of each section will then be planted some crop, and likewise with each of the other plots, so that in any year some crop will be growing on ground treated with all of the six fertilizers, both with and without lime. Rotation of crops will probably be introduced, but the ground will receive the same fertilizer year after year. A special experiment with alum treated sludge will also be started on other ground.

At the date of September 15, the farm was already growing late potatoes, beans and fall cabbage. It is proposed to plant spinach and grass seed in the fall and next spring to add another crop, probably tomatoes, making a total of six different crops.

*Report, made on October 10th, of the Committee on Sludge of the American Public Health Association, consisting of Langdon Pearse, chairman; T. Chalkley Hatton, C. H. Hurd, Earle B. Phelps and W. L. Stevenson.

The preparation of air dried sludge for the year 1922 cost $.666 per ton.

ROCHESTER

Mr. John F. Skinner reports that at the Irondequoit plant of the city of Rochester, N. Y., about 10,600 cubic yards were prepared for market in 1922 by air drying. This sludge was sold at an average price of $0.75 per load of 2 cubic yards to farmers, delivery being made by a tipple to the teams and auto trucks. When shoveled from storage only $0.50 was received by the city. The sludge is largely used in the top dressings of the orchards for a distance of 7 miles around the plant.

HOUSTON

From Houston, Mr. J. C. McVea reports that during the calendar year 1922, 4 cars of sludge were sold. The buyers preferred sludge which had not been pulverized. Five tons were delivered to local truck growers and others for use near Houston. The results obtained by various gardeners and by the Houston City Park Superintendent on the municipal golf course and in the parks have been very gratifying. Growing experiments were made on a small scale with turnips, tomatoes, lettuce and radishes, in which the value of the sludge as a fertilizer was demonstrated. In particular, the turnips were vastly improved, the ones fertilized with sludge being the only ones edible, being sound and sweet, the others being dry and fibrous. The results on the turnips are given by the following table:

Percentage Increase Over Unfertilized Turnips

No.	Weight in Ounces			Per Cent Increase			How Fertilized
	Total	Roots	Tops	Total	Roots	Tops	
1	11	3	8	0	0	0	Not fertilized
2	18	7	11	64	133	38	Blood
3	41	14	27	273	367	237	Nitrate Soda
4	63	28	35	473	832	338	Activated Sludge
5	59	31	28	426	932	250	Activated Sludge and Phosphoric Acid

Production Data and Analysis of Sludge Reported for 1922

City	Baltimore	Rochester	Chicago	Houston
Plant	Hydrolytic-	Imhoff	Activated	Activated
Production in 1922, net tons dry weight	5,421	6440	400*	70†
Air dried cu. yd.		10600		
Analysis on dry basis		Per cent		
Nitrogen—				
Average	2.45	2.00	5 0	4.6
Maximum		2.17	5 6	
Minimum		1.95	4.3	
Phosphoric Acid	0.52	0.8	2 to 4	1.9

*Approximate amount on 12 months, 1922-3
†Produced for experimental use and sold as fertilizer. Estimated production would be 1,720 tons, if prepared.

PREPARATION OF SLUDGE

In the preparation of the sludge, development of methods and apparatus is still progressing with very encouraging results.

At Milwaukee, the tests have been concluded on sludge handling, with the conclusion that provision should be made for the use of acid and heat with the Oliver filter.

At the Des Plaines River Sewage Treatment Plant of the Sanitary District of Chicago dewatering has proceeded using alum, or acid, with and without heat. At first only a Worthington bag plate press and a Simplex plate press were available. In August tests were begun on a novel hydraulically operated bag press, designed by Berrigan, with direct squeeze, which has the advantage of taking care of any desired thickness from ¼-inch upwards. The press cake (in moisture content fom 73 to 83% moisture) is dried in a rotary direct-indirect dryer. A pulverizer is required to crush the balls which occur, though not in large number.

At the Calumet Sewage Treatment Works of the Sanitary District, dewatering has proceeded using alum or acid on the Oliver filter installed. This filter is the largest size built, the drum being 11 ft. 6 in. diameter with a face 14 ft. wide. Space has been left in the house for a Basco-ter-Meer centrifugal. A dryer similar to the one at the Des Plaines River Sewage Treatment Works operates on the sludge cake intermittently.

At the testing station operated jointly by the Sanitary District and the Corn Products Refining Company at Argo, tests have been run on plate filters and a single wheel American rotary filter. Alum has proved more successful as a coagulent than acid.

At Houston, the cost of preparing the sludge has not yet developed to a point where definite costs can be given. Several methods have been tried. At present the use of sulphur dioxide gas is being tried to prepare the sludge for pressing. There has been no complaint of odor from sludge handling or the preparation of the sludge.

The nitrogen recovery in activated sludge at the various points of operation is as follows:

Recovery of Nitrogen and Phosphoric Acid from Activated Sludge

Nitrogen as N; Phosphoric Acid as P_2O_5; Per cent dry basis.

Location	N	P_2O_5
Sanitary District of Chicago—		
Argo	7 to 8	6 to 7
Tannery	3.0	
Parkingtown	4.2	2.7
Des Plaines R. S. T. W.	4.5 to 5.5	2 to 4
Calumet S. T. W.	4.2 to 4.4	
Houston	4.6	1.9
Milwaukee	6.0	2.3

By the alkaline permanganate method the total available ammonia in the Milwaukee sludge is 4.61 per cent, 63 per cent of the total ammonia.

Paving Brick Production

The report by the National Paving Brick Manufacturers' Association of the production and shipments of paving brick for the month of August, compiled from figures submitted by companies representing 69% of the capacity of the industry, showed orders received during the month for about 13½ million plain wire-cut brick 3x4x8½; 3¼ million plain wire-cut 3½x4x8½; 5½ million repressed lug 4x3½x8½; ⅛ million wire-cut-lug 3x3½x8½; 1½ wire-cut-lug 4x3½x8½; and no wire-cut-lug 3½ x3½x8½. The shipments during the month were approximately 14½ million plain wire-cut 3x4x8½; 6 million plain wire-cut 3½x4x8½; 9 million repressed lug 4x3½x8½; ¾ million wire-cut-lug 3x 3½x8½; and 3½ million wire-cut-lug 4x3½x8½.

The above are all recognized standard sizes and varieties. In addition, there were shipped during the month 2½ million No. 1 brick of varieties no longer recognized as standard, while orders were

received for one million of such special brick. The orders, which apparently would be the best indication of present practice, showed choice of about 25 times as many of the standard varieties as of those not now recognized as standard. As the unfilled orders showed a ratio of only about 10:1, the indication is that consumers are rapidly accepting the new standards and abandoning those which were eliminated by the agreements made a few months ago.

The figures were arranged by the association by states and also as to use on city streets or country highways. The latter classification showed that about 26 million of those shipped were intended for city streets and only 7.4 million for country highways. Shipments were made during August for country highways in Illinois, Indiana, Kentucky, North Carolina, Ohio, Pennsylvania and West Virginia. In the majority of these states the number of bricks shipped for city streets greatly exceeded those shipped for country highways, the notable exceptions being North Carolina, with 168,000 for country highways and 191,000 for city streets, and Ohio with 5,784,000 for country highways and 5,781,000 for city streets. Shipments for city streets were made to 25 states and Canada.

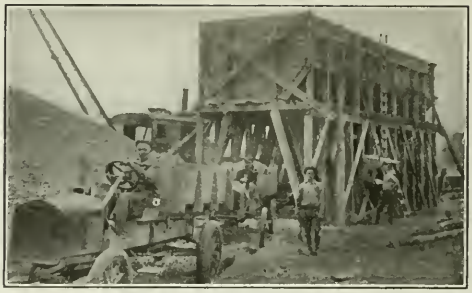
Good Work on Dixie Highway

Methods and plant employed by contractor in building 12½ miles of this road in Kentucky, of rock asphalt on a concrete basis.

The Dixie Highway, extending from the Great Lakes to the Gulf of Mexico, is unlike most national highways in that it does not follow a single line. For a portion of its length it is split into two approximately parallel lines, usually designated the Eastern Dixie and the Western Dixie.

Both branches of this highway traverse the State of Kentucky, one entering the state at Covington, and the other at Louisville. The latter branch traverses level or rolling country in its course across the central part of the state. About half of the Eastern Dixie is through similar topography but when it leaves the Bluegrass section of the state, it enters the coal and timber fields and runs through the Kentucky mountains to the Tennessee line. Both sections of the Dixie Highway are being extensively improved by the State Highway Department.

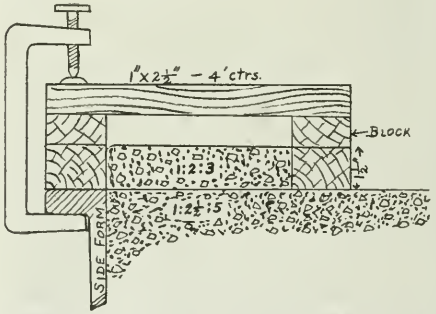
One of the most interesting portions of the Eastern Dixie is the contract being executed by Metzel, O'Hearn, Vastine and Lewin between Barbourville and Pineville. This is a 12½ mile contract which is being paved with Kentucky rock asphalt on concrete base with integral curbs. The base is 6 inches thick, of 1-2½-5 concrete and the surface is 1½ inches thick. The curbs are 6 inches wide, finishing flush with



BINS FOR AGGREGATE, AND STOCK PILE.

the asphalt surface, and the mixture is 1-2-3. The road is 16 feet wide on tangents, increased to 18 or 20 feet on curves. The grading was done last year under another contract.

The contractors are building the entire 12½ miles from two set-ups. The first was at the northern end of the contract; later the plant was moved to a point about 2½ miles from the southern end. Additional set-ups were not practicable, largely because intermediate points were not accessible to the railroad. The unloading was done with an Erie crane on caterpillars equipped with ¾-yard Blaw clam-shell. The cars were spotted at the crane by a Fordson tractor, following which the aggregate was removed to either the bins or the stock pile. To facilitate unloading hopper cars, two concrete pits were constructed at the side of the railroad track to receive the aggregate, from which it was taken by the clam shell. This equipment handled from 8 to 10 cars of aggregate per day. The bins were equipped with a pair of Blaw-Knox batchers, one delivering stone or gravel, and the other sand. The cement was unloaded directly from railroad cars to the trucks, any surplus being placed in the warehouse. Two or three cars of cement were used each day. Dry batches were drawn to the mixer by a fleet of Ford trucks varying from 8 to 17, depending on the length of haul. After receiving its coarse and fine aggregate, the truck was driven past the cement platform where the cement was dumped by hand upon the aggregate. Arriving

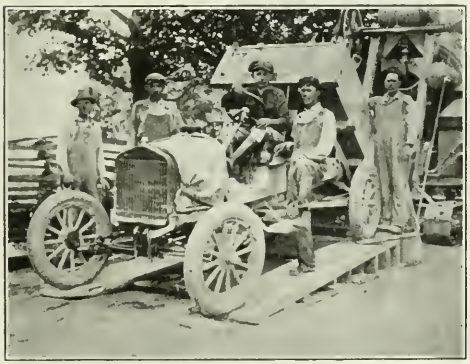


FORM FOR CURB CLAMPED TO STEEL SIDE FORM.

CONCRETE MIXER, AND INCLINED RUNWAY FOR RECEIVING TRUCK.

at the mixer, the truck was run onto a turntable, turned around and backed to the mixer and the batches dumped into the hopper from an inclined portable runway. The mixed concrete was discharged on the subgrade between Blaw-Knox steel forms and was compacted and shaped by hand and a wooden templet. The mixer was a 21 E Smith, gas-driven, mounted on caterpillars.

The method of building the integral curbs seems to be unique. A portable box was carried along each side of the road and into this a batch of 1-2½-5 concrete was dumped as needed. Additional cement and sand to bring it up to a 1-2-3 mix was added by hand for use in constructing the curb. The form for the curb was made of light wood built in 12-foot sections, which produced a form easily handled and bent to curved alignment where necessary. One side of this form rested on the steel form and the other side on the concrete base, the whole being clamped to the steel form. The curb concrete was placed in this wooden form by hand and finished with trowels. No difficulty or delay whatever was experienced in forming the curbs, which was contrary to the experience of many contractors.



TRUCK DUMPING FROM INCLINED RUNWAY

When the concrete base had partially set and before the curb forms were removed, the surface of the base was scored in three directions by means of a hand-drawn corrugated roller, the corrugations being about 2 inches apart and extending ½ inch into the concrete. By pulling the roller across the pavement in three directions a very uniform and positive scoring of the base was secured, which was designed to prevent crawling of the asphalt.

The rock asphalt was unloaded by means of the Erie crane into trucks and was placed on the base in the customary manner by the use of hand labor and rollers.

Water for the entire project was supplied by a Barnes triplex road pump mounted on wheels and operated by a 4-cylinder gasoline automobile engine, driving the pump through a clutch and gears. The pressure at the pump was 275 lbs., which gave a pressure of 85 lbs. at the mixer through three miles of 2-inch pipe.

This work gives an impression of being unusually well organized and equipped. Every piece of equipment seems perfectly fitted for its place and well balanced with the rest of the outfit and the contractors report that the equipment is even more satisfactory than they had anticipated.

The progress made on this work is very commendable when it is understood that only one outfit is employed on the job. Laying concrete began April 16 of the present year and 10 miles had been completed on September 4, the last five miles having been laid in 35 days or 360 hours of actual operation. The maximum day's run of concrete was 1,335 lin. ft. in 12½ hours, while the maximum in laying asphalt was 1,040 ft. and the average about 850 ft. The contractors anticipate completing the last 2½ miles of base and surface in 30 days.

The work is being done under the personal supervision of the four members of the firm, with J. Steve Watkins as District Engineer for the State; G. L. Logan, Assistant District Engineer, and Jas. Gard, Resident Engineer.

Street Widening in Akron

Akron, Ohio, on October 15, completed its most important street widening improvement, that of West Market Street. One of the interesting features of this improvement was that, while a bond isue of $625,000 was authorized for the work and $450,000 of bonds were sold, the actual cost was only $433,000.

Director of Service W. F. Peters states that the cost was reduced chiefly by following a new procedure in condemning and appropriating property. A number of large buildings projected beyond the street as widened and the city purchased not only the buildings but also land in the rear of them and contracted for moving the buildings back onto this land, thus salvaging a considerable percentage of the value of the buildings which it at first was thought would have to be destroyed or largely rebuilt with new fronts and shallower depths.

Recent Legal Decisions

DATE OF FILING CLAIMS ON MUNICIPAL CONTRACTS IN MASSACHUSETTS

The Massachusetts Supreme Court holds, Hurley v. City of Boston, 138 N. E. 838, that under Mass. St. 1909, c. 514, §22, requiring statements of claims of subcontractors on municipal contracts to be filed within 60 days after completion of the work, a contract providing that the date of completion shall be decided by the architect binds the subcontractors by his decision if he acts in good faith and uses his best judgment, but where he makes no examination or inspection of electrical, heating, ventilating and plumbing work, and relies on the judgment of others, without exercising his own, his decision is not binding.

PROPERTY OWNERS ALLOWING IMPROVEMENT TO PROCEED CANNOT OBJECT TO ASSESSMENT

The New Jersey Supreme Court holds, Graham v. Ocean City, 119 Atl. 772, that where a city has been permitted to go on and incur the expense of an improvement (in this case the construction of a bulkhead) without objection to the validity of the ordinance, and then assesses the benefits, it is too late for property owners to object to the assessment on the ground of the invalidity of the original ordinance.

EXCAVATION FOR CELLARS IS WORK ON ERECTION OF BUILDING UNDER BUILDING PERMIT

Where an ordinance requires the submission of a detailed description of the proposed work to the building commissioner before the erection, construction or alteration of any building, and provides that work shall not be commenced until a permit is issued, the Massachusetts Supreme Court holds, Commonwealth v. Atlas, 138 N. E. 243, that actual excavation for cellars of proposed buildings constituted work on the erection and construction of a building within the ordinance. The making of foundations is as essential for a building as the fabrication of its walls.

CONFORMITY OF ENGINEER'S ESTIMATE TO ORDINANCE

The Illinois Supreme Court holds, Ownby v. City of Mattoon, 306 Ill. 552, 138 N. E. 110, that no fatal variance exists between the engineer's estimate for a paving improvement and the ordinance therefor because the estimate makes no provision for a top dressing, while the ordinance so provides, where the estimate provides for the amount of yardage of brick paving, the cushion therefor, the base of the paving, and the filler to be used in the cracks to bind the brick together and make a uniform surface; the Illinois courts holding it unnecessary that the estimate of cost should contain a complete inventory of every article that is to enter into the construction of the improvement (Village of Donovan v. Donovan, 236 Ill. 636, 86 N. E. 575).

Nor is there a variance because the estimate provides for 9,000 feet of curb 5 inches in width, etc., while the ordinance specifies the curb shall be 5 inches wide at the top and 6 inches wide at the bottom. The curb is still a 5-inch curb, the ordinance merely describing what it shall be where it joins the gutter-flag.

ACQUITTAL OF CODEFENDANT OF NEGLIGENCE BAR TO RECOVERY AGAINST CITY WHOSE LIABILITY IS DERIVATIVE

The Supreme Court of Appeals of Virginia holds, Sawyer v. City of Norfolk, 116 S. E. 245, that where a pedestrian was thrown down and injured by the violent opening of a restaurant screen door extending 23 inches over the sidewalk, and brought suit against both restaurant and city for negligence, an acquittal of the restaurant was a bar to recovery against the city, its liability being derivative and dependent upon the negligence of the restaurant. The same question has been decided in the same way in Indiana, New York, New Hampshire, Rhode Island and Illinois.

PLAINTIFF IN ACTION FOR EXCAVATION ACCIDENT MUST SHOW THAT NEGLIGENCE CAUSED INJURY

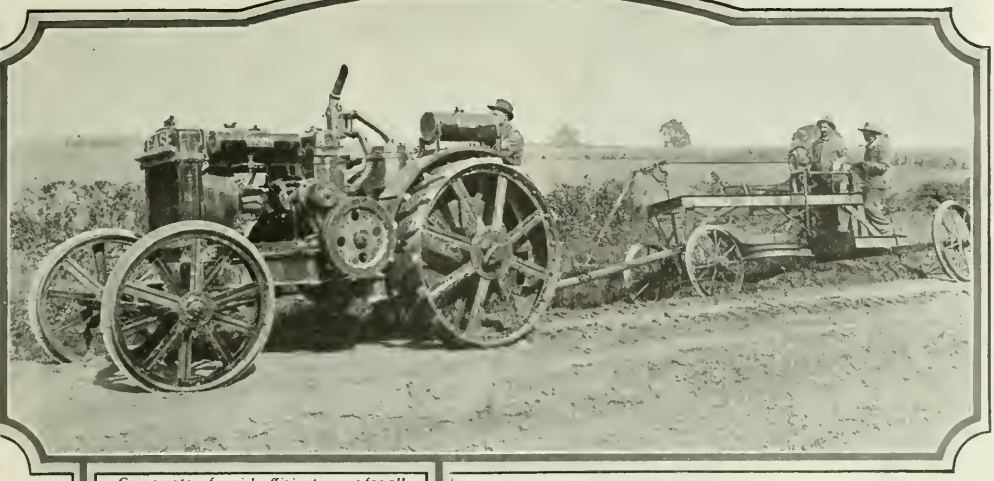
In an action against a paving contractor by a husband for injuries to his wife caused by her falling while walking over an excavation, the Missouri Court of Appeals holds, Waldmann v. Skrainka Const. Co., 249 S. W. 698, that assuming that the defendant company was guilty of negligence by violation of the ordinance of the city of St. Louis requiring excavation in or adjoining an alley to be fenced with a substantial fence not less than three feet high, it would still be necessary to prove the negligence alleged, that defendant cut the south edge of the sidewalk so as to leave the edge rough and jagged, and dangerous to pedestrians, and also to show a causal connection between the accident and the negligence charged to make a case for the jury.

CITY HELD NOT LIABLE FOR ILLNESS CAUSED BY INSANITARY CONDITION OF DEFECTIVE SEWER

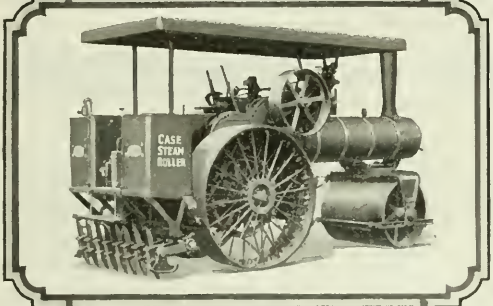
The North Carolina Supreme Court holds, Saudlin v. City of Wilmington, 116 S. E. 733, that where a city maintained a nuisance consisting of overflow of sewage from a defectively constructed sewer on the plaintiff's premises, and she sues for damages for her illness caused thereby, and not for any injury done to the property or to her interest, if any, therein, she is not entitled to damages for personal discomfort caused by the alleged nuisance.

CITY BOARD CANNOT, WITHOUT AUTHORITY, PURCHASE INTANGIBLE ASSETS OF COMPETING UTILITY

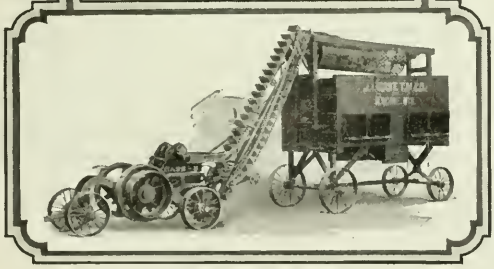
The Georgia Supreme Court holds, Board of Lights and Waterworks of Marietta v. Miller, 116 S. E. 835, that a city board of lights and waterworks, which has no authority to purchase the intangible assets of a competing electric light and power business, could not expend the city's money either on express or implied contract to effect such unauthorized objects and purposes.



Case tractors furnish efficient power for all road building machines and operations.



Case steam roller—10 and 12 ton sizes. Develops over 40 H.P. on the brake. Normal traction speed 2¼ M.P.H. Large capacity fuel bunkers and water tank. Economical, dependable, durable.



This compact, portable crushing plant has large volume for the power required, great strength, and durability. Breaks stone into uniform size, fine or coarse as desired

Three Exceptional Road Building Machines

The Case Tractor

Case tractors are designed specially to meet the need of road builders for dependable, economical power. They are compact, easy to handle at traction and belt work, and exceedingly durable.

Generous reserve power, proper weight distribution and effective traction speeds insure good, fast work under all conditions.

There are four sizes: 12-20, 15-27, 22-40, 40-72, an efficient size for every operation.

The Case Steam Roller and Scarifier

For many years the Case Steam road roller has been a recognized leader in its field. The addition of a practical, steam operated scarifier of unusual strength and efficiency makes this a highly efficient machine for modern road construction. It is equally satisfactory for belt work and can be used as a hauling engine.

The Case Rock Crusher, Screen and Bin

This handy, portable outfit comes in two sizes, with capacities of 10 to 25 tons per hour. Crushers are of the jaw type. Screens separate stone into four sizes, each falling into its own compartment in the bin, from which it is loaded into wagons by pulling down a spout on either side.

These three machines, necessary in all extensive road work, are our contribution to better and more profitable road building. Make your files complete by writing for full information.

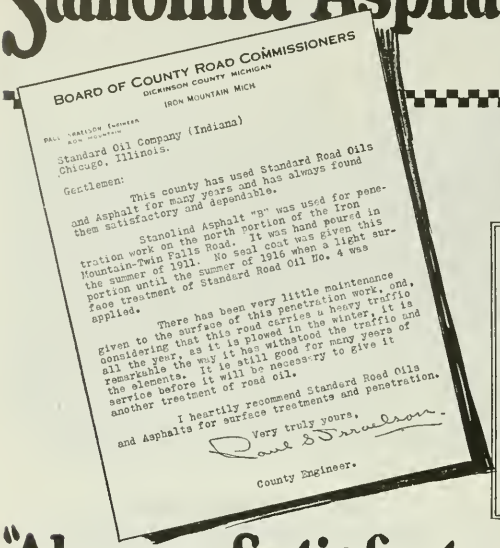
J. I. CASE THRESHING MACHINE COMPANY

[ESTABLISHED 1842]

Dept. M90

Racine • Wisconsin • U • S • A

Stanolind Asphalt - *Iron Mountain, Mich.*



BOARD OF COUNTY ROAD COMMISSIONERS
DICKINSON COUNTY MICHIGAN
IRON MOUNTAIN MICH

Standard Oil Company (Indiana)
Chicago, Illinois.

Gentlemen:

This county has used Standard Road Oils and Asphalt for many years and has always found them satisfactory and dependable.

Stanolind Asphalt "B" was used for penetration work on the north portion of the Iron Mountain-Twin Falls Road. It was hand poured in the summer of 1911. No seal coat was given this portion until the summer of 1916 when a light surface treatment of Standard Road Oil No. 4 was applied.

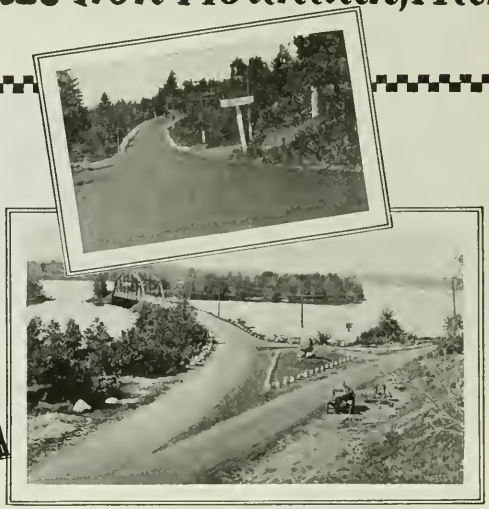
There has been very little maintenance given to the surface of this penetration work, and, considering that this road carries a heavy traffic all the year, as it is plowed in the winter, it is remarkable the way it has withstood the traffic and the elements. It is still good for many years of service before it will be necessary to give it another treatment of road oil.

I heartily recommend Standard Road Oils and Asphalts for surface treatments and penetration.

Very truly yours,

Paul Israelson

County Engineer.



"Always Satisfactory *and* Dependable."

YOU can give the taxpayers of your community good, permanent roads at a low cost of construction and maintenance if they are built by the penetration method, using Stanolind Paving Asphalt.

Economy of construction is characteristic of this type of pavement. Expensive machinery and labor are not necessary to lay it properly. Old road beds can usually be left in place if subgrade and base are in good condition. Local rock or stone can often be used and transportation charges saved.

Long life and low maintenance cost are also inherent and important features of Stanolind Asphalt roads. The hard pounding of heavy, speeding traffic is absorbed by the resilient water-proof surfaces. Neither the heat of summer nor the cold of winter affect them detrimentally. The Iron Mountain-Twin Falls Road has withstood twelve years of continuous, heavy traffic and twelve northern Michigan winters, and it is still good for many more years of service, although Mr. Israelson's letter states that very little maintenance work has been done.

Stanolind Asphalt roads are an asset to any community. They are the arteries of transportation which, year after year, support its business and social life. If your community will build its roads now with Stanolind Paving Asphalt, you, too, will say, ten, fifteen or perhaps fifty years from now: "It is remarkable the way *they* have withstood the traffic and the elements."

If you have not received your copy of our booklet telling the latest methods of constructing and maintaining asphalt pavements, we suggest that you write us at once. It will be a valuable addition to your business library. Use your official stationery, please.

STANDARD OIL COMPANY
(INDIANA)
910 S. Michigan Avenue CHICAGO, ILLINOIS

Rebuilt, from the bottom—**up!** That's the Gray Giant system of street and road maintenance.

Take any unpaved street or road, no matter how neglected, rutted, or hard-packed into bumps and pot-holes; the Gray Giant Combination Tractor - Scarifier - Grader-Roller will completely **rebuild** it, from bottom to top, at a speed of 1 to 1½ miles of rebuilt highway per day.

This 16,000 pound machine reduces operating costs up to **$55 a day.**

Gray Giants are enthusiastically used in the four corners of the country.

Send for descriptive folder "C D."

Gray Giant

Combination Road-Street Rebuilder and Maintainer

1. *Scarifies*
2. *Crushes*
3. *Grades*
4. *Rolls*

Available for road construction work—hauling up to 10-foot grader.

Also belt work.

Powered with 50 H. P. Waukesha motor.

Weight, 16,000 pounds.

"Built on the Gray Standard of Excellence—Sold on Its Performance"

THE GRAY TRACTOR COMPANY, Inc.

MINNEAPOLIS, MINN.

5 Nassau Street
New York City

WICHITA, KANSAS

Third and Hamilton Streets
San Pedro, Calif.

168 No. Michigan Avenue
Chicago, Ill.

WINNIPEG, MANITOBA

Bingamon Street Bridge, Reading, Pa., crossing the Schuykill.
Designed by C. F. Sanders, County Engineer, Berks County, Pa.

Bridge at Olympia, Wash. Elastite Expansion Joint used.

Protecting great bridges against temperature

TEMPERATURE fluctuation, and the consequent expanding and contracting of these great concrete masses, are rendered harmless to the durability of big bridges and viaducts by the installation of Elastite Expansion Joint at regular intervals.

The fact that Elastite Expansion Joint, "the sandwich joint," is handled as a slab, in any dimension and thickness, makes installation comparatively simple and easy. It is the practical joint used exclusively by practical engineers and contractors. It is easily cut to shape with an old saw, or can be supplied cut to exact fit to meet your requirements.

When you need "joint," remember that there are big stocks of Elastite Expansion Joint in seventeen cities. Your order will be immediately shipped to your job from the nearest point. Send for sample and all the facts.

THE PHILIP CAREY COMPANY
10 Wayne Ave., Lockland, Cincinnati, Ohio

Carey Elastite Expansion Joint is used in these bridges and viaducts

Akron Ohio — North Hill Viaduct
Augusta, Ga. — Archibald W. Butts Memorial Bridge
Bethlehem, Pa. — Hill-to-Hill Bridge
Cincinnati, Ohio — Park Avenue Bridge
Fort Wayne, Ind. — Harrison Street Bridge
Galveston, Texas — Galveston Causeway
Hawkinsville, Ga. — Ocmulgee River Bridge
Kansas City, Mo. — Benton Boulevard Viaduct
Little Rock, Ark. — Broadway Bridge
Oahu, Hawaii — Heeia Viaduct
Pulaski, New York — Salmon River Bridge
Reading, Pa. — Bingamon Street Bridge
St. Louis, Mo. — Chauteau Avenue Viaduct
St. Louis, Mo. — Jefferson Avenue Bridge
Laredo, Texas — Laredo International Bridge
Washington, D. C. — Key Bridge
Watertown, New York — Grove Street Bridge

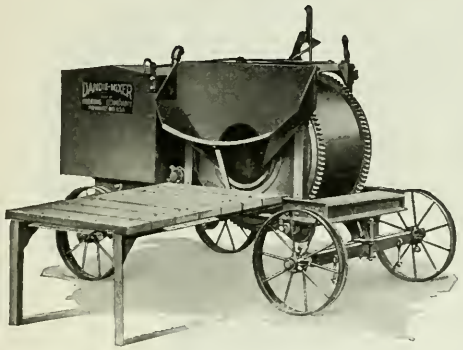
Carey Elastite EXPANSION JOINT
TRADE MARK REG. U.S. Pat. Office
PROVED AND ACCEPTED

Carey Elastite Expansion Joint is an asphaltic body, formed of a high-grade asphaltic compound carefully refined and tempered, sandwiched between two walls of asphalt-saturated felt forming an elastic, compressible joint. It is made in lengths, widths and thicknesses as required, can be cut to crown or to any special shape and comes to the job ready to use.

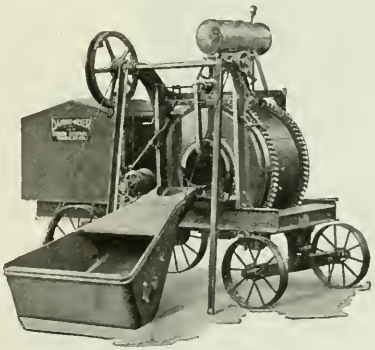
12-23

DANDIE

The KOEHRING Light Mixer



104 S—4 Cubic Feet Mixed Concrete



107 S—7 Cubic Feet Mixed Concrete

Get the Price — Get the Specifications

NO, it's not the cheapest mixer in price—but it is the greatest *value* in the light mixer class and it is within the light mixer price range. It will outwork, outwear and outlast ordinary light mixer construction. It will still have a long profitable future ahead of it, when the ordinary light mixer is costing you big money to keep it out of the junk pile!

Send back the coupon. Get the Dandie catalog that informs you how to judge mixer values. You'll find it a practical, helpful, money-saving booklet.

Dandie Capacities

4 and 7 cu. ft. mixed concrete, steam and gasoline. May be equipped with power charging skip, low charging platform, light duty hoist, automatic water measuring tank. Mixes mortar as well as concrete. Send back the coupon today.

KOEHRING COMPANY

Manufacturers of Concrete Mixers, Cranes, Draglines, Shovels

MILWAUKEE, WISCONSIN

Sales offices and service warehouses in all principal cities.

KOEHRING COMPANY
MILWAUKEE, WIS.

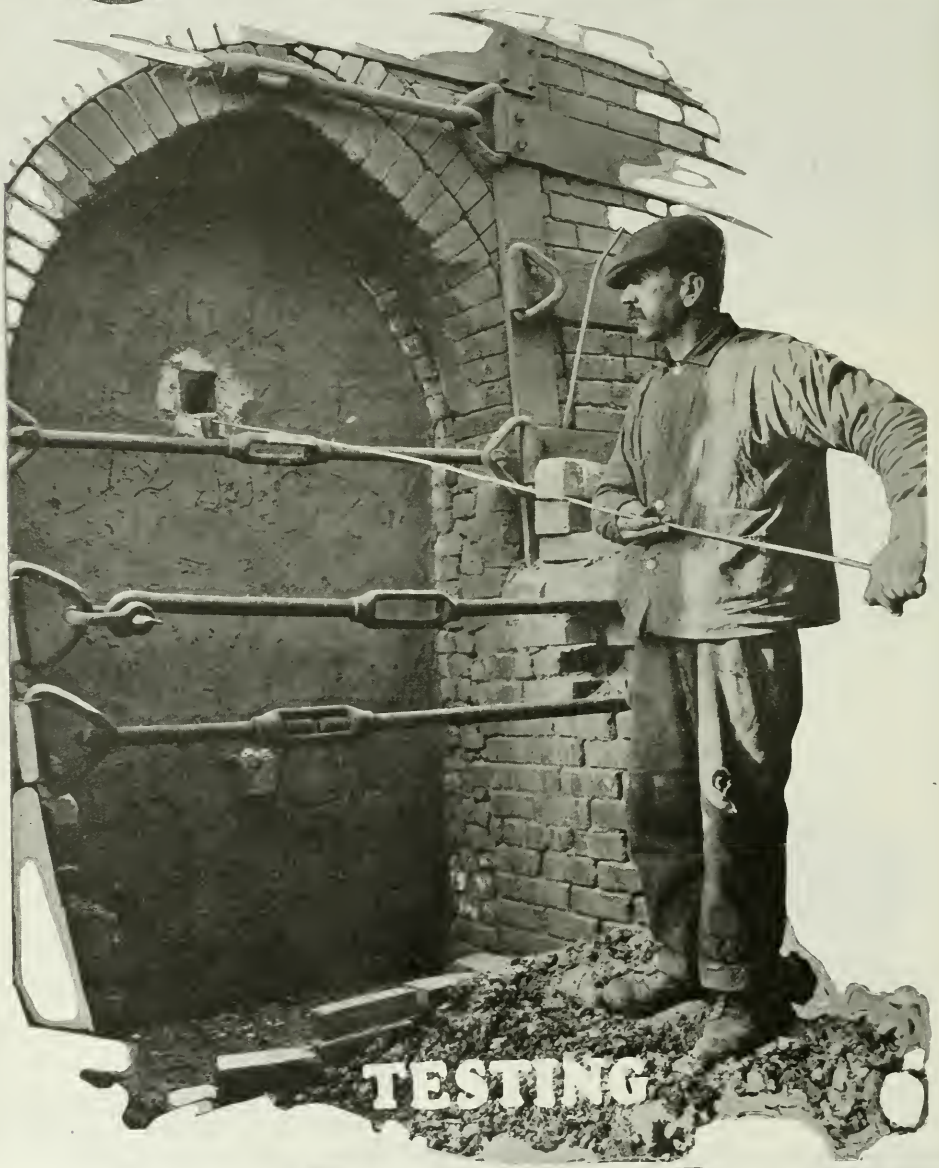
Please send me Koehring Dandie Mixer Catalog No. P. 14 and give full information on interchangeability for mixing concrete and mortar.

Name ----------

Address ----------

Foreign Department, Office 1370, 50 Church St., New York City;
Canada, Koehring Company of Canada, Ltd., 105 Front Street, East, Toronto, Ontario;
Mexico, F. S. Lapum, Cinco De Mayo 21, Mexico, D. F

TESTED BY FIRE



TESTING

A series illustrating the present day practice and processes

VITRIFIED CLAY PIPE

From mine to finished product

A block of cones for determining various temperatures is placed where they can be readily observed through the peephole. These cones are composed of clays which have definite fusing temperatures and fuse to a shapeless mass when these temperatures are reached in the kiln.

In many plants pyrometers are used in conjunction with the cones to record the temperatures at the various stages of fusing. Test pieces are also placed in the kiln where they can be easily reached by a hook through the peephole. These test pieces are removed at intervals and show the progress of the burning and the glazing.

VITRIFIED CLAY
The Pipe Everlasting

In the average clay the first signs of fusing occur at about 1750°f. Vitrification is completed when the pipe reaches that stage of fusion beyond which the pipe would be melted down to a shapeless mass.

Great care and precaution are necessary to maintain the proper heat for the process of burning and glazing and are very important to the final strength and quality of the pipe.

Eastern Clay Products Association

Henry T. Shelley, Secy., Mgr. :-: Phone Spruce 5029

906 Colonial Trust Building, Philadelphia, Pa.

Members Eastern Clay Products Association

The Buckeye Fire Clay Co.
Uhrichsville, Ohio

Cambria Clay Products Co.
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Clearfield Sewer Pipe Co.
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Crouse Clay Products Co.
Akron, Ohio

The Dennison Sewer Pipe Co.
Dennison, Ohio

East Ohio Sewer Pipe Co.
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Robinson & Sons Sewer Pipe Co.
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Ross Clay Products Co.
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"Servicised"

Since concrete slabs expand and contract with season changes and since there is no way by means of the concrete itself to overcome this natural phenomenon, expansion joints must be used to protect the road from seepage.

Thus it is not a matter of restricting the use of expansion joints but rather of seeking the very best joints obtainable and using them at frequent intervals.

Admittedly, joints that do not expand when the slabs contract and contract when the slabs expand are useless. They should not be considered. And since Servicised Expansion Joints will do the job and remain resilient indefinitely, there is no longer need for considering inferior old-type impregnated joints. A "Servicised" concrete road can always have the "O. K." of its builder.

There are four types of Servicised Expansion Joints in all of which the oozing tendency is controlled.

Write for samples and prices

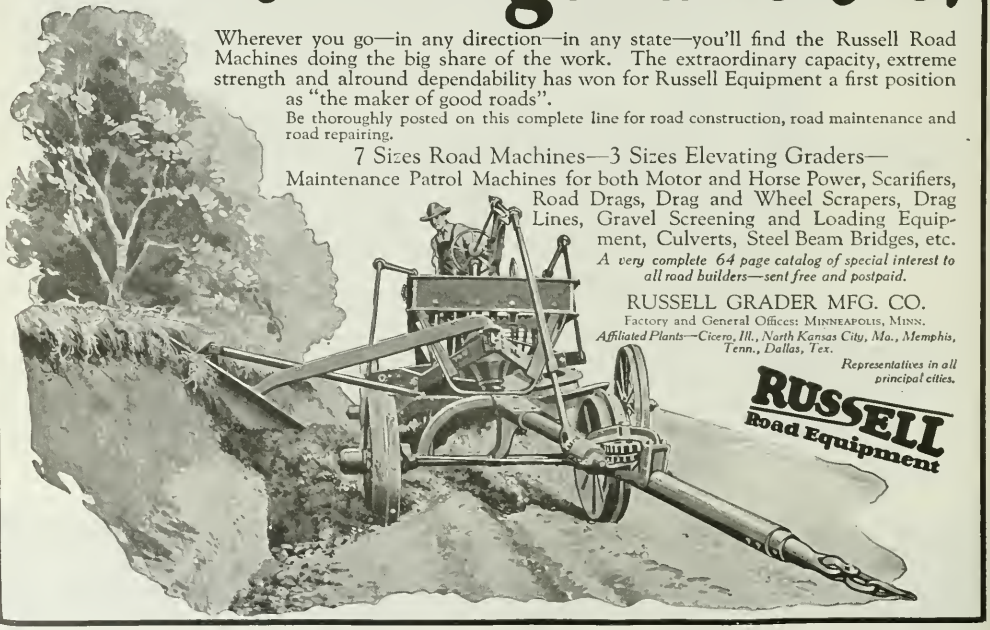
SERVICISED EXPANSION JOINTS

Service the Crevice and Save the Road

Servicised Products Co.

1528 First National Bank Bldg. Chicago.

The maker of good roads!



Wherever you go—in any direction—in any state—you'll find the Russell Road Machines doing the big share of the work. The extraordinary capacity, extreme strength and alround dependability has won for Russell Equipment a first position as "the maker of good roads".

Be thoroughly posted on this complete line for road construction, road maintenance and road repairing.

7 Sizes Road Machines—3 Sizes Elevating Graders—
Maintenance Patrol Machines for both Motor and Horse Power, Scarifiers, Road Drags, Drag and Wheel Scrapers, Drag Lines, Gravel Screening and Loading Equipment, Culverts, Steel Beam Bridges, etc.

A very complete 64 page catalog of special interest to all road builders—sent free and postpaid.

RUSSELL GRADER MFG. CO.

Factory and General Offices: Minneapolis, Minn.

Affiliated Plants—Cicero, Ill., North Kansas City, Mo., Memphis, Tenn., Dallas, Tex.

Representatives in all principal cities.

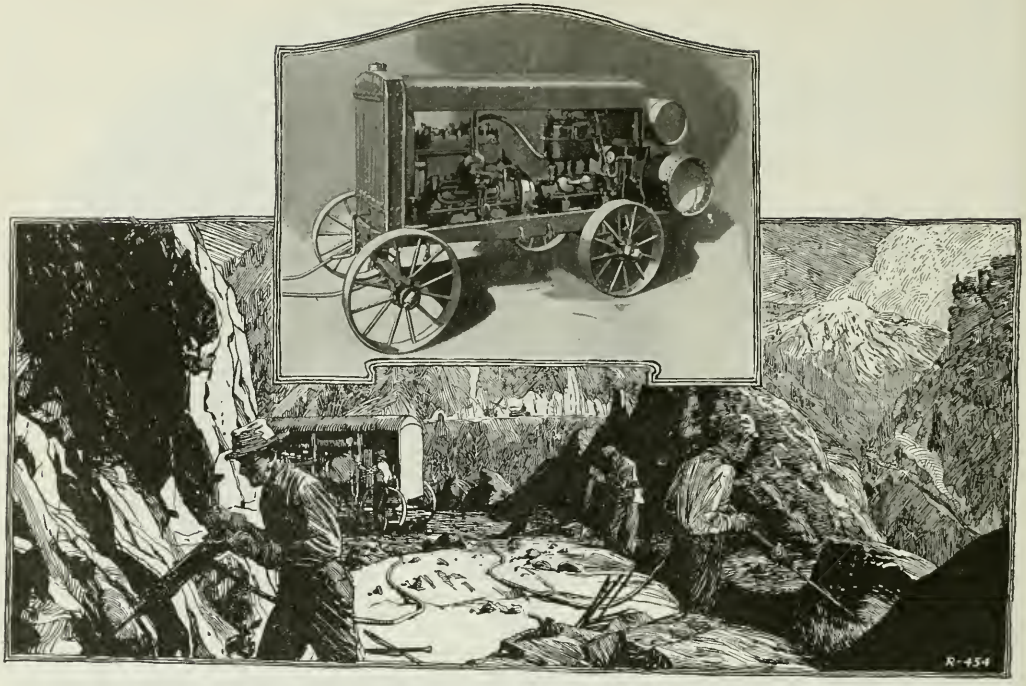
RUSSELL Road Equipment

The King of the Black Tops says:—

"A Wish for the New Year
For You—

Friendships a little warmer—
Happiness a little richer—
Achievements a little greater—
Success a little sweeter
and the whole year

'Best by Every Test'"



PORTABLE COMPRESSORS
For Development Work or Road Building

It is costly in money and time to install a stationary steam or electric driven compressor plant for prospect or development work. With the portable Compressor you can get on the job quickly and easily and have the work well along before a stationary plant could be erected. All you need is an Ingersoll-Rand Portable Compressor and drilling equipment—both are easily moved and always ready for work.

For road building, trench work or rock removal over an extended area, Portable Compressors and one man "Jackhamer" drills are the acknowledged standard. The ease with which these can be moved about and operated, the freedom from heavy fuel haulage and erection makes these machines the ideal portable rock drilling equipment.

Ingersoll-Rand Portable Compressors are complete, compact, self-contained air power plants suitable for mine development, rock work, etc. Compressor, tractor type gasoline engine (or electric motor) air receiver, cooling water system and accessories are mounted on a covered steel truck with removable side covers. Sizes 91, 160 and 210 cu. ft. per min.

Ask our nearest branch office for complete information on Portable Compressors, Rock Drills and Drill Steel Sharpeners

INGERSOLL-RAND CO., 11 Broadway, N. Y.

Offices in all principal domestic and foreign cities

For Canada refer Canadian Ingersoll-Rand Co., Limited, 260 St. James St., Montreal, Quebec

745-C

Ingersoll-Rand

A Pair of Highway Builders In One

The H. P. One Man Grader

With H. P. Rigid Rail Tracks

Also Furnished With Whitehead & Kale Wheels

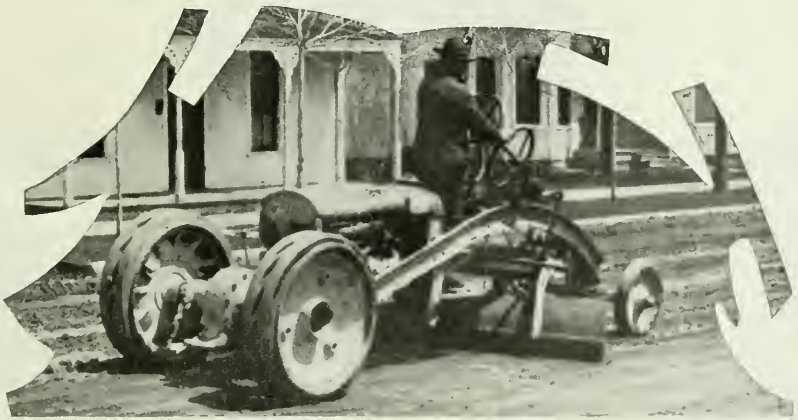
The H. P. One Man Grader.

The One Man Grader with either Whitehead & Kale Wheels or Rigid Rail Tracks is a wonderfully efficient, speedy and money making road grader. It will operate easily with one man and will do more than 2 ordinary graders, 4 teams and six men.. Equally good on new work or road patrol. Every township road organization should have one or more. Rigid Rail Tracks make soft or rough going easy. They make a crawler of your Fordson and make it do things it couldn't do without Rigid Rail Tracks.

Can be fitted with wheel equip ent to give traction under any condition.

Either or both the Grader and the Tracks are quickly attached to your Fordson. Circular on request.

The Hadfield-Penfield Steel Co., Bucyrus, Ohio



JAEGER
CONCRETE MIXER

Every Jaeger Display Room a Complete Mixer Show in Itself!

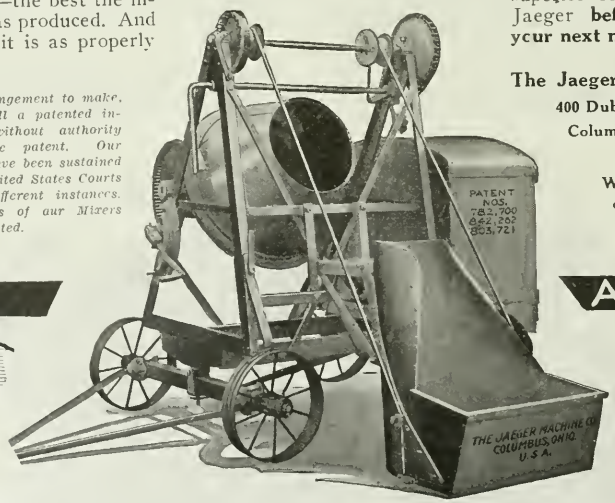
The Jaeger Line includes 24 different outfits, in four different sizes—mixers with and without loaders, hoists, water tanks, engines—mounted on trucks or skids—equipped with steel wheels or wheels with rubber tires. Big and small mixers—ranging in capacity from 2½ cu. ft. to 14 cu. ft. mixed concrete. Every model of known efficiency and dependability.

Every Unit Built Right

If your requirements demand a heavy duty mixer, by all means get the facts about the big-capacity Jaeger models. They have built a world-wide reputation. Long experience and engineering skill have made every Jaeger unit—Tilting Drum, Power Loader, Tip Over Water Tank, Hoist and Engines—the best the industry has produced. And every unit is as properly co-ordinated as in the production of a high-grade automobile or truck.

That's why Jaeger heavy duty mixers as well as the smaller models have set the standard for the concrete mixer industry—a standard that is recognized throughout the world. Get all the facts about the superior features of the Jaeger **before you buy your next mixer.**

It is infringement to make, use or sell a patented invention without authority under the patent. Our patents have been sustained by the United States Courts in six different instances. Purchasers of our Mixers are protected.

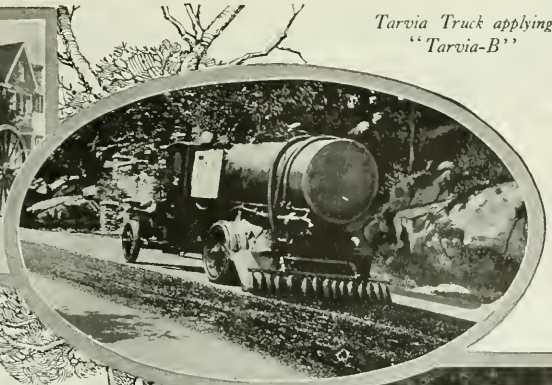


The Jaeger Machine Co.
400 Dublin Avenue
Columbus, Ohio

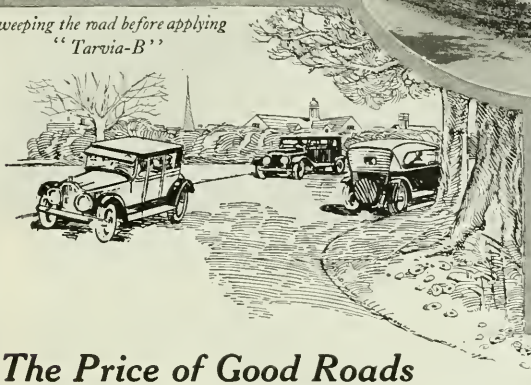
Write for catalog today!

A MIX A MINUTE

Sweeping the road before applying "Tarvia-B"



Tarvia Truck applying "Tarvia-B"



Spreading gravel by hand after applying "Tarvia-B"

The Price of Good Roads is Eternal Maintenance—

EXPERIENCE has proved that every type of modern road or highway requires regular, systematic upkeep to withstand the grinding wear of modern traffic.

And experience has also proved that every type of improved road can be satisfactorily and economically maintained with Tarvia. Hundreds of cities, towns, and rural communities throughout the United States and Canada, after experimenting with various methods and materials, today employ Tarvia maintenance on their streets and highways.

Tarvia, preeminent as a road-building material, is made in special grades that are unequalled for reconstructing, repairing and maintaining all types of improved roads — from gravel-surfaced country highways to city pavements. Tarvia keeps every type of good roads good, at minimum cost and with minimum interruption to traffic.

Send for Your Copy of "Road Maintenance With Tarvia"

You are interested in economical maintenance for the roads of your community —you want to *keep* your roads good so that larger sums will be available for additional road construction. Then send for "Road Maintenance with Tarvia." This is an interesting 56-page booklet containing 89 illustrations showing how Tarvia maintenance is applied to various kinds of road construction. Address "Tarvia Service Department," at our nearest branch. Write today!

Tarvia
For Road Construction Repair and Maintenance

The Barrett Company

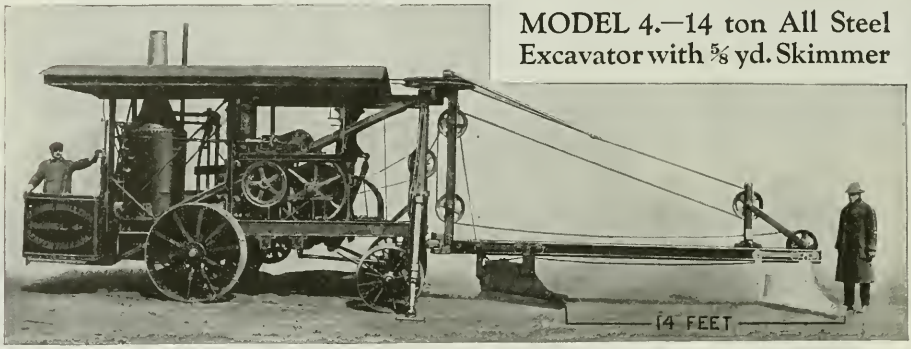
New York	Chicago	Philadelphia	Boston
St. Louis	Cleveland	Cincinnati	Pittsburgh
Detroit	Kansas City	Birmingham	Dallas
Minneapolis	Salt Lake City	Bethlehem	Lebanon
Youngstown	Milwaukee	Toledo	Columbus
Baltimore	Syracuse	New Orleans	Rochester

THE BARRETT COMPANY, Limited:
Montreal Toronto Winnipeg Vancouver St. John, N. B. Halifax, N. S.

STEAM KEYSTONE SHOVELS

TRADE MARK
REGISTERED U. S. PATENT OFFICE

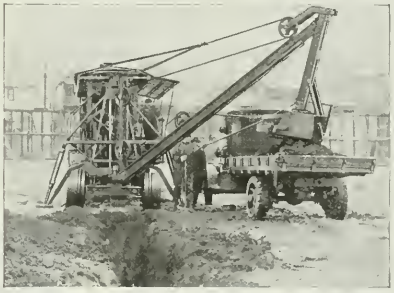
MODEL 4.—14 ton All Steel Excavator with ⅝ yd. Skimmer



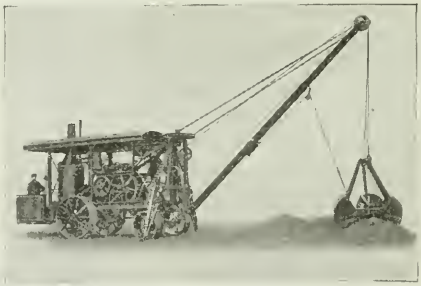
The KEYSTONE is a highly versatile traction steam shovel with all the efficiency of specialized design, usable with three different interchangeable scoops—*Skimmer, Ditcher and Clam Shell*—for Road Grading, Trenching, Back-Filling, Cellar Digging, Pit Mining, Loading, Unloading and Handling Materials. Can be equipped with electric motor drive for use in buildings. Saves first cost, moving cost and upkeep and is readily sold or rented for any sort of excavation job. A reliable road shovel of remarkable adaptability to other uses.

The heavy Keystone Skimmer Bucket, ⅝ yd. capacity, has a horizontal crowd of 14 feet and fills itself at one shot in a six inch cut. It leaves a smooth surface, finished to grade and thus dispenses with costly hand-trimming. Shallow digging in hard material—old macadam, paving blocks, concrete and asphalt—is keystone work.

Made in two sizes: Model 3, 10 ton and Model 4, 14 ton. The good Keystone Digging Ideas in our catalogs and advertising sheets have made money for 1500 Contractors in the United States. Ask for them.



Ditcher



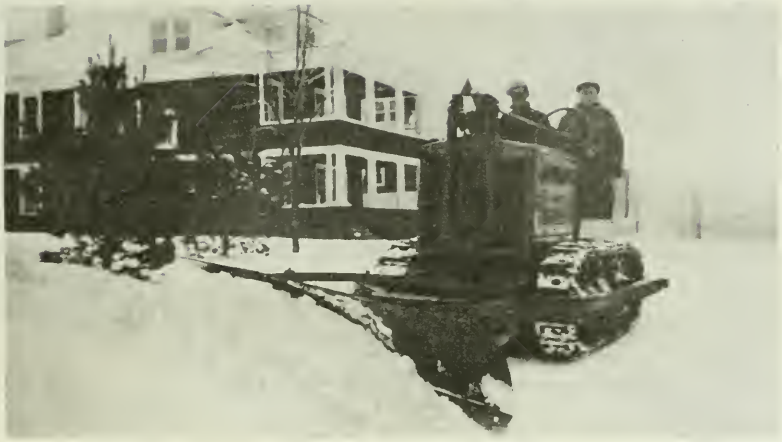
Model 4, with Boom extension and ½ yd. Clamshell Bucket.

Keystone stands on the solid. No cribbing needed, no danger from cave-in, of machine sliding into excavation. Any width or depth to 20 feet. There is 4 feet of water in this 12 foot ditch. The Keystone is adapted for hard going among roots, boulders, etc., and cleaning out blasted rock.

Keystone Driller Company, Beaver Falls, Pa.

170 Broadway, New York Monadnock Block, Chicago Joplin, Mo.

8-D-4



Actual photograph, Woodbury, N. Y.

Woodbury, N. Y., Is Prepared! (Is Your City, too?)

The annual snow peril already hangs over many Northern cities. In some localities, the public may be made to suffer for interrupted traffic, snowbound fire equipment, stalled ambulances, trolleys and all other traffic.

But not in Woodbury, N. Y.! Wm. McClellan, supervisor for that progressive city, tells how Woodbury has conquered the snow problem:

"Appreciating the importance of keeping our roads open during the winter months we purchased a 10-Ton "Caterpillar"* with snow-plow. Before the tractor arrived there was an accumulation of about a foot of snow from the winter storms, and the "Caterpillar" outfit cleared the roads without difficulty and kept them open throughout the winter.

"The power developed by "Caterpillars" equips them to go through practically any snow-storm and they are the only dependable method we know of for clearing snow from the highways. The "Caterpillar" travels 3 to 4 miles an hour and the outfit is operated by two men. For our purpose we estimate that it should do the work for at least ten years, and we have a feeling of satisfaction in knowing that we are able to take care of a snow-storm at present that kept us laboring for days with all the forces we could command."

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PUBLIC WORKS.
CITY COUNTY STATE
A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"
Vol. 54 December, 1923 No. 12

Memphis' New Waterworks*

A new system of wells and new pumping plant replacing the old. Reducing high carbonic acid and iron content of the well water by aeration and filtration. Wells and well houses located on residence properties.

By F. G. Cunningham†

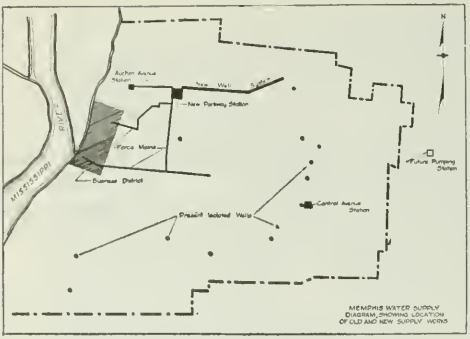
There is now being constructed at Memphis, Tennessee, a new water supply works which is not merely an extension or supplement to the old works but replaces practically all of them except the distribution system. The total cost will be approximately $2,800,000. The new works contain a number of features of more than ordinary interest, some of which are described below.

EXISTING WORKS

Memphis has a population of about 165,000 and the average consumption is about 13,000,000 gallons per day. For thirty-three years it has obtained its water supply by means of drilled wells from a stratum of sand known as the LaGrange formation. Since the first wells were put in service in 1890 the ground water plane has lowered between 5 and 10 feet, probably because of the frictional resistance in the sand due to the growing demand. The wells were scattered widely over the area of the city, those first driven contributing about 7,000,000 gallons daily to the Auction Avenue station, while others driven in 1908 contribute about 4,000,000 per day to the Central Avenue station, about 4 miles east of the other. Since then the supply has been further increased by fourteen isolated pump-

*Condensed from a paper before the American Society for Municipal Improvements.
†Resident supervising engineer for Fuller & McClintock, the designing and constructing engineers.

VIEW OF INTERIOR OF ENGINE ROOM.
Air compressors are seen along the left wall and pumping engines being assembled along the right of the central aisle.



LOCATION OF OLD AND NEW WATER SUPPLY WORKS OF MEMPHIS.

ing stations scattered about the outskirts of the city, each containing an electrically driven centrifugal deep-well pump delivering water directly into the mains, the total amount from these isolated stations being about 9,000,000 gallons daily.

A study of the population records led to an expectation that by 1950 the population will be 300,000 and the average daily consumption 31,000,000 gallons.

These combined facilities are now proving inadequate, are inexpensive of operation and in rather poor physical condition, and after thoroughly investigating the present plant the engineers decided that no part of these works could be retained to advantage in the new development.

At the request of the city officials, a separate high pressure fire protection system was considered but was not recommended, as it was believed that its cost could be applied with greater good to betterments of the general water system and fire engine apparatus, and this opinion was endorsed by the National Board of Fire Underwriters.

It was advised that a new station could be located convenient to the western part of the city in which is found about three-quarters of the population and all of the downtown business district and most of the industrial plants, this station to have a capacity to serve the entire city for a period of seven or eight years, at the expiration of which period another development could be constructed further east, in which direction it is expected that the city will grow, the station now being completed thereafter to serve the older or western portion of the city alone.

RIVER WATER VS. WELL WATER

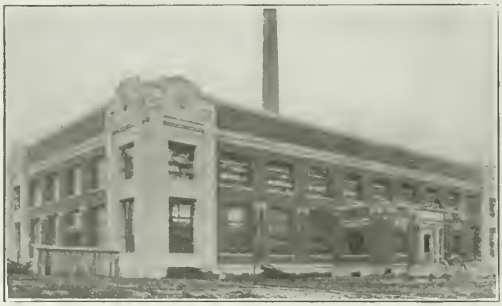
Two sources of supply were considered—wells and the Missouri river. There appeared to be abundance of ground-water available and this is naturally excellent in quality, being clear, cool, soft and practically free from organic matter and bacteria. However, it contains carbonic acid ranging from 90 to 130 parts per million, which makes it highly corrosive of cast-iron pipe, and also contains iron in quantities varying from 0.2 part to 6 parts per million, whereas when the amount exceeds 0.4 part it causes unsightly stains on plumbing fixtures, kitchen utensils and clothing washed in it. On the other hand, the river water is much harder than the well water and noticeably warmer in summer, and it would cost more to remove the sediment and bacteria from the river water than to remove the iron and carbonic acid from the well water; also a satisfactory intake in the river would be difficult and expensive to construct. (See PUBLIC WORKS for October, 1922). It was therefore decided to continue the use of well water but to treat it by removing a large part of the dissolved iron and carbon dioxide.

Good water-bearing sand is reached at a depth of 300 to 450 feet and varies in thickness from 50 feet to 150 feet. It outcrops about 40 miles to the east in an irregular strip about 40 miles wide and 250 miles long.

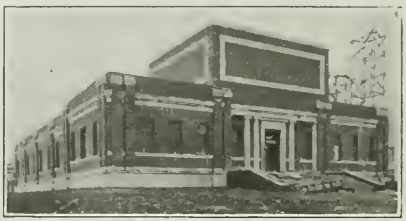
It was found by chemical investigation that the water now being pumped from the wells by air lift is much better as regards iron and CO_2 than that pumped by other methods, the former method not only removing 80 per cent. of the CO_2 but bringing the iron to a highly dispersed or colloidal condition, in which condition it is less troublesome than in the usual forms. Air lift pumping, however, does not *remove* the iron nor take out enough of the CO_2 to prevent the effluent from attacking iron pipes, and it was decided, after considerable experimenting, to equip the new station with means practically to eliminate these two constituents from the water.

THE WELLS

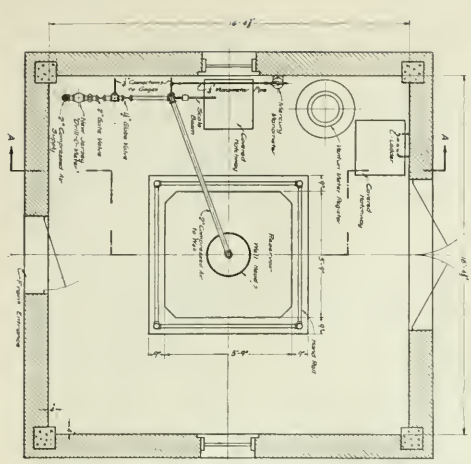
Whereas the present wells are widely



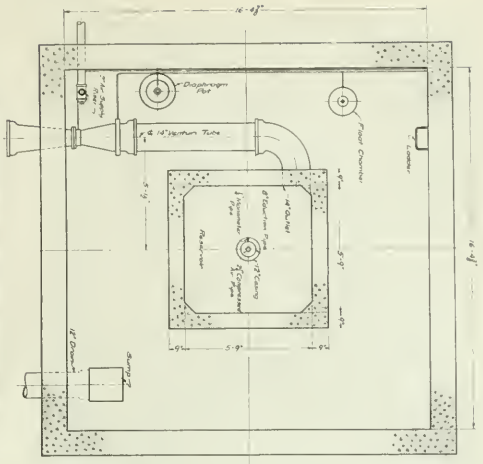
FRONT OF PUMPING STATION.



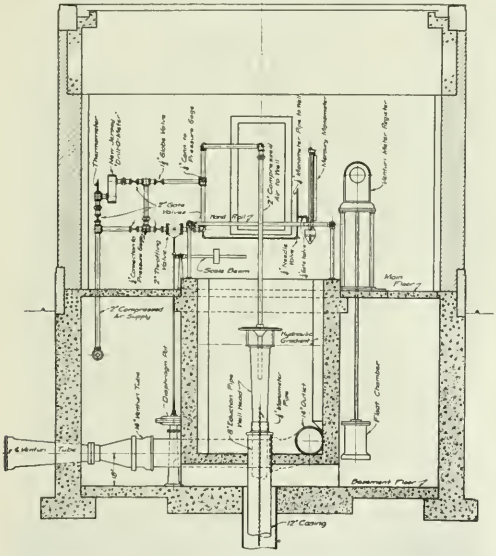
FRONT OF IRON REMOVAL PLANT.
Tower in center encloses wash-water tank.



MAIN FLOOR PLAN OF WELL HOUSE.

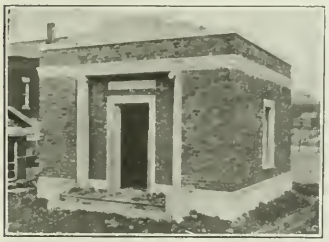


BASEMENT FLOOR PLAN OF WELL HOUSE.



SECTION ON THE LINE AA.

scattered, it is proposed in the new works to take the supply from a relatively small underground area. This will naturally cause more interference between wells than at present, but this will be more than offset by the economy of having a single treatment plant and pumping station and short lines connecting these to the wells. Twenty-three wells will be provided and are expected to furnish an average daily consumption of 18,000,000 gallons and a maximum consumption of 24,000,000 gallons, which quantities are made the basis of the design of the station and treatment plant also, after making allowances for reserve apparatus. The average depth of well will be about 475 feet. The casing will be 12 inches diameter and the upper hundred feet of each will be jacketed with an 18-inch casing carried down to an impervious stratum to provide a double safeguard against the entrance of surface water. The eduction pipes will be 7½-inches diameter and in the center of these will be air pipes of 2¼-inch casing. Each eduction pipe will discharge into an open concrete tank where air and CO_2 may escape. From this tank the water will pass through a Venturi meter and a branch pipe to a gravity collecting main. The tops of the eduction pipes will be set to a fixed hydraulic grade rising from the main station.



FRONT OF A TYPICAL WELL HOUSE.

AERATOR BUILDING DURING CONSTRUCTION.
Shows grill work windows for free circulation of air.

The pumping station and treatment plant are located upon a 10-acre site at the westerly end of a pretty residential street with a wide central mall of grass and shrubbery. The wells extend eastward from the station in a line about two miles long, four being upon the station site, fourteen upon residence lots along the parkway, and five at the easterly end upon a right-of-way paralleling the railroad. Because of the location along this residential parkway, each well head will be covered with a house of neat appearance, the exterior being of mat-faced brick trimmed with Bedford limestone, and the ground surrounding it will be neatly sodded and planted with shrubs.

Over each well will be a well house containing a basement in which will be placed the meter tube, controller diaphragm and meter float chamber and which will be permanently drained through a 12-inch tile sewer. When a well is overhauled (which will probably be at intervals averaging not less than six years apart), the sand and water will be discharged into one side of the basement and drain away through this tile, thus concealing the unsightly litter that ordinarily accompanies such operations. When it is necessary to remove an eduction pipe for repairs, this will be done by means of a portable derrick set upon the roof. For this purpose a slot 30 inches wide and extending the full depth of the house will be left in the roof and provided with a removable sheet-metal cover. The portable hoisting engine used when these repairs are being made will be operated by compressed air in order to minimize the nuisance to the neighbors.

In each house will be meters and gauges and specially designed automatic controllers to regulate the air flow and to prevent waste of air. An operator will be able to note, by stepping inside the door, the rates of air flow and of water flow and the elevation of water in the well, or to change the setting of the controllers.

The water in the wells will be raised to the ground level by air lift, compressed air for which will be supplied by compressors located in the pumping station and carried by pipes which, together with the collecting water-pipes, will be buried in the central mall of the parkway. Compressed air is furnished through four principal mains of 6 to 10-inch diameter, made of steel with joints gas welded except that Dresser sleeves will furnish expansion joints at intervals of 300 feet.

The water from the wells will flow by gravity through a cast-iron collecting main to a receiving or equalizing basin at the station. Here centrifugal secondary pumps will raise the water about 25 feet to the aerator, where practically all of the CO_2 then remaining will be removed. From the aerator the water will pass by gravity through the iron removal plant, which is simply a set of ordinary rapid sand filters, and the finished product will then flow to the suctions of the high-service pumps. A 10,000,000-gallon filtered water storage basin is connected to the conduit supplying the high-service pumps and will provide reserve storage for fires and hourly peaks.

PUMPING STATION

The illustrations show the general appearance of the station buildings, which were designed by Jones & Furbringer, Memphis architects, with the idea of securing a good appearance without extravagance or without sacrificing utility. It is expected to beautify the grounds and to place six public tennis courts upon the roof of the storage basin.

The main part of the pumping station is 225x125 feet, with a rear wing for a shop and a front wing for the office. The south end of this station will contain four 350-horsepower horizontal water-tube boilers, with underfeed stokers and complete mechanical coal and ash handling equipment. The operating steam pressure will be 200 pounds with a superheat of 75 to 200 degrees.

(To be continued)

Road Construction in Hayti

The presence in Hayti of United States forces has resulted not only in stabilizing the government and preventing internal disorders, but also is resulting in public works of which little is heard in this country. The accompanying illustrations show highway work being conducted in charge of the United States Marine Corps, Commander A. L. Parsons being the chief engineer. This is a gravel road with rolled dirt shoulders. The gravel is obtained from a pit by hand-shovelling and carried by wheelbarrows to a crusher. The gravel runs about 15% sand and the whole material is placed in the crusher, which is so adjusted that when run through a screen with 1-inch circular openings not more than 10% passes through as tailings. The crusher turns out about 4 cubic yards per hour.

A concrete pit was constructed under the crusher and elevator and the crushed material is lifted by elevator to the screen and the material passing the 1-inch openings drops into a portable

GRAVELING THE SCARIFIED ROAD SURFACE.

bin. In order to eliminate dust, a canvas canopy was built over the bin as shown. The crusher is operated by a Farquhar 20-horsepower steam tractor, one of the front wheels of which was removed because it interfered with the drive belt.

In constructing the road, it is first scarified and the large stones raked out. The gravel is then placed and brought to a crown with a road form, the ditches being dug and shoulders built up. The road is then rolled thoroughly with a 10-ton roller. In addition to the steam tractor, the plant includes two Reliance portable stone crushers with folding elevators, the crushing plants and the tractor being furnished by the Universal Road Machinery Company of Kingston, New York, to which we are indebted for these photographs and information.

Raising a Heavy-Traffic Street

West street, New York, is a marginal thoroughfare adjacent to North river and from Cortlandt to Duane street is bounded on the west by ferry, railroad and steamship slips, and on the east chiefly by commission stores, markets and some other business buildings. In this locality it is about 200 feet wide and carries an extremely heavy traffic of taxis and automobiles, including large numbers of heavy trucks. It is also crossed at street intersections by great numbers of commuters going to the various ferries. On the east side of the street there were two disused street-car tracks.

The surface of the street, which was paved with granite blocks, is only a short distance above mean high tide and was pitched from both sides downward to the center line, where there were inlets to an old egg-shape brick sewer about 3 feet in diameter. The center of the street was so low that water would occasionally back up through the sewer inlets and stand on the pavement in the center of the street.

To remedy this condition, a new system of drainage has been adopted, the street being changed from a dished to a crowned cross-section and catch-basins and inlets being provided at both curbs. The new surface is being paved with granite blocks, and catch-basins, curbs and some sidewalks are being built.

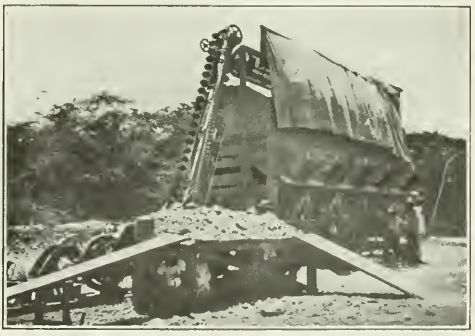
The contract for this, approximating $500,000, was awarded to the Asphalt Construction Company, which commenced operations in April and completed the work in December. The principal quantities involved are: about 25,000 cubic yards of fill, 9,000 cubic yards of concrete foundation 6 inches thick, and 47,000 square yards of new granite block pavement; besides a line of 12 to 16-inch cast-iron sewer pipe along the east curb.

A strip about 20 feet wide along the east side, where the surface tracks ran, required a small amount of excavation, which was satisfactorily done with a Fresno scraper. Elsewhere the original surface was generally left undisturbed except where the granite blocks were considered worth removing and redressing for sale by the contractor and where the old center line sewer was exposed, broken up and backfilled to make a solid roadbed.

Operations were commenced on the east side of West street at Cortlandt street, and the grading and fill of the street were carried on in three successive longitudinal strips so as to leave about two-thirds of the original width of the street open for traffic, which was shifted successively from the old to the new pavement as the work progressed. The final strip of the improvement, on the west side of the street, was executed in alternate, transverse sections, running from the completed longitudinal sections up to the pier and ferry slips and always providing access from one side of a slip before it was removed on the other side.

The fill, which varies from about 1-1/2 to 4-1/2 feet and has an average depth of about 3 feet, consists chiefly of earth and sand from building excavations nearby, and was trucked to the site and placed in position, or piled on the finished or unfinished pavement, according to the condition of the work and the supply, which varied from 0 to 100 truckloads daily. The fill was spread in layers, watered, and thoroughly rolled with a 10-ton Kelly-Springfield steam roller.

TRACTOR ENGINE OPERATING PLANT. BURNS WOOD CUT AT THE SITE.



CHARGING PLATFORM, CRUSHER, ELEVATOR AND BIN.

The subgrade was covered with 6 inches of concrete mixed in a 2-bag Koehring paving machine, which averaged about 100 square yards per hour, notwithstanding the limited space and interruption from congested traffic. Broken stone supplied by the New York Trap Rock Company, sand from Brooklyn, and Portland cement in bags, were delivered by truck and piled in the street. The stone was dumped in long, continuous piles, and afterwards handled by a Barber-Greene loading machine, mounted on caterpillar traction, having a measuring box suspended from the top of its elevator arm. Sand was shovelled by hand into one compartment of a 2-wheel, 1-horse cart, which was then hauled under the stone loading machine and received in the other compartment the quantity of stone required for one batch of concrete. The cart was then hauled a very few feet and dumped into the charging hopper of the mixer.

Considering the enormous amount of heavy truck and taxi traffic carried by this street, and that it was filled to a maximum depth of 4½ feet before paving, the interruption to traffic was not very serious, although two traffic police at each corner had their hands full during the busiest hours.

Cement Bids for Indiana Roads

It is reported that for the first time since the Indiana State Highway Department began building concrete roads it has apparently received actual competitive bidding on cement, bids on November 15 for 1,500,000 barrels ranging from $1.65 to $1.82 a barrel at the mills, seven companies bidding. In 1923 the prices bid were from $1.60 to $1.75.

Passaic Valley Sewer

Nearing completion after twenty-seven years of investigation, litigation and construction. Further action for removal of trade wastes necessary.

After eleven years of preliminary engineering, legal and financial investigations and disputes by former state commissions, the Passaic Valley Sewerage Commission was appointed in 1907 to provide for sewering the cities in the lower Passaic River Valley, and the date of December 31, 1912, fixed as that beyond which there should be no discharge of polluting materials into that river. This date has been advanced from time to time and the intercepting sewer has been under construction during a large part of the sixteen years. William Gavin Taylor, deputy chief engineer of the commission, reported recently that the sewerage works are nearing completion, the principal unfinished item being the tunnel beneath New York Bay. On November 15, when Mr. Taylor wrote, there were two gaps to be completed, one of 80 feet between the bay shaft and the shore shaft and the other of 1,350 feet between the bay shaft and the terminal chamber. On November 20 the former gap was closed, the two compressed air shields meeting with a difference of alignment of 3 inches horizontally and less than an inch vertically. It was believed that about 12 weeks more would see the entire completion of the boring of the tunnel to the terminal chamber.

The total length of the tunnel is about 9,300 feet. Construction of it was begun several years ago, but the contract was abandoned first by one contractor and then by a second and the tunnel is being completed by the commission under the direction of its chief engineer, J. Ralph VanDuyn. Work is being prosecuted continuously with three shifts a day. About 70 feet a day of progress was being made a short time ago and it was expected that this would be increased to 90 feet or more by additional facilities which were being provided.

The commission's engineers expect that sewage can be diverted from the river before warm weather next year. The approach of this event makes it desirable to emphasize the fact that this sewer alone will not effect complete or even very considerable purification of the Passaic river. While this river receives the unpurified sewage of most of the municipalities in its drainage area, the most objectionable part of the pollution in its lower stretches is due to liquid wastes from silk dyeing and other plants. The statute provides that the sewer shall receive domestic sewage, but not more than 10 per cent of the factory wastes. In designing the sewer allowance was made for a total volume of 60,640,000 gallons of trade wastes daily, which is about 20 per cent of the capacity of the sewer. The statute, however, also provides that it will be unlawful to discharge polluting matters into the river and the commission is empowered to enforce this provision. Much of the waste waters consist of condensing, cooling and wash waters, which are not considered polluting, and, if kept separate from the other wastes, could be discharged directly into the river.

Where the polluting waste is not large it may, under the 10 per cent provision, be discharged into the sewer. If, however, there is a very large or abnormal amount of offensive trade waste, the burden of disposing of it should be borne by the industry as a part of its production expense. If any of the wastes consist of matters which would result in disintegration of the masonry or endangering the lives of employes or the public, or otherwise injuriously affecting the integrity and usefulness of the sewer (such including gashouse wastes, strong acids, gasoline, live steam, etc.), the discharge of these into the sewer will be prohibited.

The commission is at present endeavoring to secure co-operation of all the industries in the Passaic Valley with a view to their making such changes and introducing such processes and plants as will bring about the desired withholding of pollution from the Passaic river after the

Spring of 1924. The Nutley Rotary Club has taken up with the various Rotary clubs in the Passaic Valley district the subject of securing co-operation of the manufacturers with the Sewerage Commission in securing this result.

Building North Beach Sewers

Adjacent large storm water and sanitary sewers built in deep open trench rapidly excavated by dragline and clamshell buckets and sheeted at bottom only. Duplicate concrete plant, mixers shifted every 120 feet by traveler derrick, concrete spouted 60 feet, making average of 10 feet of sewers in 8-hour shift.

By Frank W. Skinner

The outfall section of the North Beach Sewer, now under construction by Booth & Flinn, Limited, for the Borough of Queens, New York City, Captain James Rice, engineer, consists of two adjacent reinforced concrete conduits with vertical walls, flat roof slabs and arched inverts. The sanitary sewer is 9 feet 9 inches wide and 8 feet high and the storm sewer is 14 feet 7 inches wide and 8 feet high, inside dimensions. Together they contain about five yards of concrete and 250 pounds of reinforcement steel per lineal foot, require an average excavation of about 40 yards per lineal foot of sewer, and will use a total of about 36,000 bags of Atlas cement in the 6,000 yards of concrete.

The contract section adjacent to the screen chamber at the outlet, which is 1,475 feet long, was commenced in April, 1923, is now more than 80 per cent completed and it is expected will be finished this season at an estimated cost, based on unit prices and specification quantities, of about $500,000. The work is being executed by ordinary methods and an abundant installation of standard equipment and presents interesting features of organization, balanced schedule and adjustment of operations that secure continuous satisfactory progress. The rapid and economical excavation of difficult material, controlling treacherous soil and large water flow, and the smoothness and efficiency of the concreting which advances with speed and uniformity, insure steady progress with a comparatively small force.

EXCAVATION

About three-fourths of the excavation is accomplished by a steam drag-line machine with caterpillar traction and 40-foot boom operating a ¾-yard Page-Lidgerwood dragline bucket that digs the trench 35 feet wide to a depth of 24 feet, handling earth, clay, gravel and boulders at an average rate of 300 yards per day. About one-fifth of all the excavated material is dumped alongside the trench on both sides, whence it is eventually reclaimed for backfill.

After the dragline bucket has excavated to its limiting depth of about 24 feet the trench is continued to a maximum depth of 41 feet by excavation with two ¾-yard Hayward clamshell buckets that dig efficiently and fill well, leaving little or no hand digging or trimming above or below water level.

The material not reclaimed for backfill, about 44,000 yards in all, is dumped directly by the dragline and clamshell buckets into three 5-ton trucks that haul it about a mile to the spoil bank. Although the buckets sometimes dump from a height of several feet, the heavy truck bodies endure the impact and the hydraulic hoist and automatic opening and locking of the tail boards make for easy handling of the spoil.

SHEET PILING

The clay and gravel stand well with very steep sides to the trench, but the dry sand below them is very unstable and is sheeted with 3x10-inch square-edge planks 24 feet long driven as the excavation advances by two No. 5 McKiernan-Terry sheeting hammers, one of them handled by a small traveling stiff-leg derrick with 20-foot boom that is mounted on trucks running on two narrow gauge tracks carried on a light trestle, built on the slope of the excavated material. The derrick boom is operated by a single-drum Lidgerwood hoisting engine.

The sheeting is easily driven, without much injury, to a depth of two or three feet below subgrade by one hammer on each side of the trench, both operated by steam from the boilers serving the hoisting engines and driving the sheet piles much more efficiently and economically than could be done by hand, requiring only one man to handle the hammer for a short time at intervals to keep the treacherous material confined and exclude much of the ground water.

The sheet piles are pulled by the derricks or steam shovel as the trench is back-filled, to be redriven, so that a section of sheeting about 120 feet long suffices. Many boulders, some of them of one yard or more, are encountered and are handled with the clamshell and dragline buckets without blasting.

GROUND WATER

Considerable difficulty is had with numerous large springs encountered in the bottom of the trench, the water from which is chiefly handled by two Domestic diaphragm gasoline pumps with 4-inch suctions, each with a capacity of about 150 gallons per minute. When bad leaks occur the water is collected in sumps, the bottom is excavated in small bulkheaded sections if necessary and the pumps are easily set on or near the bottom and operated continuously or intermittently until the invert has been laid and the leaks sealed, the discharge being delivered at the surface of the ground against a maximum head of about 40 feet.

Ordinarily one of the pumps is installed on the large traveler. Usually the water is handled by

one diaphragm pump operated during the 8-hour day shift, and one electrically driven, automatically controlled centrifugal pump with a capacity of 500 g. p. m. operating as required during the 16-hour intervals between day shifts. Pumping is maintained for 24 hours continuously after each section of invert has been laid.

FOUNDATIONS

In good sand the bottom is excavated to subgrade level, trimmed and the concrete invert laid directly on the sand. For about half the length of the sewer, however, the invert is in clay ground, and here transverse bents of five piles about 25 feet long are driven 5 feet apart longitudinally. Wales are bolted to both sides of them and support a plank platform, beyond which the pile tops project about 6 inches into the invert concrete, which is placed on the platform in sections 30 feet long.

The piles are driven at a rate of about 200 or 300 lineal feet per 8-hour shift by a steam hammer suspended from a derrick boom and generally driving to required elevation without cut off. On account of the nature of the ground the trench is open only a short distance beyond the

BUILDING NORTH BEACH SEWERS.
Traveler on cribbed track alongside deep trench. Concrete mixer served by wheelbarrows and spouting to forms. Excavating and backfilling by derricks. Sheeting hammer suspended from boom of small derrick on the right side of trench.

concreting, so that the piles cannot be driven far in advance and, as waiting for the driving sometimes tends to delay the work, it is done with maximum rapidity.

The sheeting is braced by three tiers of 12x12-inch transverse struts, 12 feet apart longitudinally, that engage 12x12-inch wales against the sheeting. The lowest row of struts is shifted as necessary to clear the forms and the concrete.

CONCRETING

In constructing each of these concrete sewers use is made of six 5-foot sections of standard Blaw-Knox collapsible steel forms, mounted on wheels, which are slacked off, moved forward and set for another section in two hours by a 5-man gang. The forms are light, strong and simple, the adjustments are quickly and accurately made, and they give regular finish to the concrete surface.

Broken stone, sand and cement are delivered by trucks and stored in piles alongside the trench. The aggregate is delivered by wheelbarrows from the stock pile to the adjacent ¾-yard mixer, which discharges into a 3-section steel chute delivering to the forms at a maximum distance of 60 feet in either direction from the mixer and completing a 30-foot section of walls and roof slabs in six hours. A duplicate mixer is maintained in reserve to prevent any interruption to the work through accident or repairs to the mixer.

As the work progresses the mixer is moved forward 120 feet each time by a 70-foot derrick boom of 10 tons capacity, which is installed on one corner of a traveler platform moving on the 30-foot gauge track, laid on cribwork alongside the trench.

DERRICK SERVICE

The main traveler handles timber, boulders and one of the ¾-yard clamshell buckets, which has to excavate and backfill. It is supplemented by a stiff-leg derrick and clamshell bucket on the opposite side of the trench.

The main traveler and the traveling derrick on the opposite side of the trench are each equipped with a 3-drum Lidgerwood hoisting engine which develops ample power for rapid hoisting with excess adequate for the more severe work of forcing the large clamshell bucket lips into the dense material and filling and closing the buckets. One of the derricks has also a Lidgerwood and the other derrick has a Dake swinging engine. Below the dragline excavation the sand is excavated at the rate of about 150 to 200 yards per day, and backfilled by the clamshell buckets at the rate of about 100 lineal feet of sewer in 6 days.

The concrete gang lays a 30-foot section of invert in 7 hours. Backfilling is commenced after the sewer has been completed from 7 to 10 days. The concrete is three parts Atlas cement, four parts sand and eight parts broken stone. The reinforcement steel is bent by hand at the site. Excavation was commenced at the opposite ends of the section, but concreting has been done from one end only.

The work progresses at an average rate of 5 lineal feet per day with a force of about 35 men under the direction of W. Griff, superintendent for the contractor.

Concrete Underdrains at Worcester

Failure of underdrains in sand filters, possible causes of which are suggested as organic acids from the soil, acidity of sewage, or putrefaction in the filter.

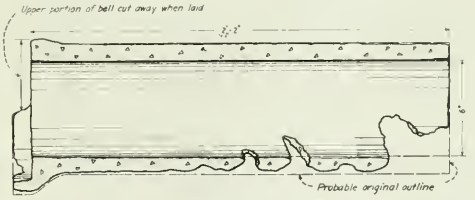
By Harrison P. Eddy *

Beginning in 1898 the city of Worcester, Massachusetts, began the construction of sand beds to be used for purifying the sewage by the process commonly known as intermittent filtration. The aggregate area of such beds at the present time is 67.61 acres net filtering area, the largest plant of this type in the United States.

The sand in these beds varies from 3 to 5 feet in depth, and is divided into units approximately one acre in area. The beds are provided with underdrains spaced approximately 35 feet apart. In the earlier years the drains were constructed of precast cement-concrete pipe laid with open joints and surrounded with graded gravel over which the sand was placed. Approximately the upper two-thirds of the socket of the pipe was broken off, the bottom third being retained in order to furnish a bed for the contiguous pipe.

When in use, the beds are flooded to a depth of

*Of Metcalf & Eddy, Consulting Engineers, Boston.



VERTICAL SECTION OF 6-INCH FILTER UNDERDRAIN.

CEMENT PIPE TAKEN FROM UNDERDRAINS OF SAND FILTERS AT WORCESTER.

3 to 6 inches at intervals of 1 to 3 days, depending upon the condition of the bed, the character of the sewage and the weather. The sewage percolates downward and laterally through the sand to the underdrains, into which it enters through the open joints, and thence flows to the main effluent channel. When in good working condition the bed drains rapidly, the flow of effluent practically ceasing within two or three hours from the time the bed is dosed. From this time until the next dose is applied, the bed is allowed to stand empty, for the purpose of aeration and oxidation.

The cement-concrete pipe used for underdrains was made of Portland cement, sand and fine gravel, thoroughly tamped into molds by hand. The proportion of water used in the mixture provided what would be termed a relatively dry mix.

The sewage contains spent pickling liquids from wire drawing establishments, foundries and other metal works; together with industrial wastes from tanneries, carpet mills, woolen mills and other industries.

The sulphate of iron contained in the spent pickling liquid is oxidized during its passage through the filters, and a substantial proportion of the iron is precipitated in the pores of the beds, particularly in the gravel surrounding the underdrains. This iron, commonly in the form of ferric hydrate, clogs the pores in the gravel and effectively seals the underdrains, so that from time to time it has been necessary to dig them up and relay them.

When the cement-concrete pipe was removed it was discovered that it had been seriously disintegrated, as illustrated by the photograph and drawing. It was found that the action was chiefly at or near the bottom of the pipe, forming grooves transversely, having an alignment similar to a spiral, with the grooves about 2 inches apart center to center. The alignment of the grooves suggests that they followed the direction of the placing and tamping of the concrete. The pipe was made in molds standing on end with the socket down. The concrete was introduced in a more or less continuous stream and constantly tamped, thus producing spiral layers approximately 2 inches thick. A possible explanation of the regularity of the action may be that the bottom of the layers of concrete were somewhat more porous than the top, due to the failure of the tamping to consolidate the layer of concrete uniformly from top to bottom of the spiral band which was about two inches thick.

While the action upon the pipe was very pronounced on the bottom, there was in most cases some action entirely around the outside of the pipe. On the inside the bottom was slightly roughened, but in some cases the top was as smooth as when originally contructed.

There appear to be three possible causes of the action upon the concrete. *First*, many of the filter beds were built upon a shallow layer of peat—roughly 2 feet in depth. Before the underdrains were constructed, however, trenches were excavated through the peat to the underlying sand. These trenches were refilled with sand and the pipe laid in it. Thus the underdrains were at a lower elevation than that of the normal surface of the peat. They were also practically at the elevation of ground water, so that after the effluent had entirely drained out of the sand, the pipes were generally in contact with the ground water. It is possible that this water may have absorbed from the soil organic acids which attacked the cement and caused the destructive action.

A *second* explanation is that the acid in the sewage attacked the concrete. The spent pickling liquids from the wire mills are discharged in relatively large quantities at intervals during the day. The acidity imparted to the sewage, on the average amounted to 75 parts per million (equivalent to 0.008 per cent), expressed in terms of sulphuric acid. The acidity of the sewage during the brief periods when it contained heavy doses of spent pickling liquors was probably as high as 500 parts per million (equivalent to 0.05 per cent). The disintegration of the cement-concrete pipe may have been due to the direct action of the acid upon the concrete.

A *third* possible explanation is that the disintegration was caused by putrefactive conditions within the filters. The volume of sewage applied to the beds was such as to overload them and occasionally, particularly during the winter and spring, putrefaction took place to such an extent that the sand at the bottom was frequently black, due to sulphide of iron formed in the pores of the filter. This may have been due in part to the sulphur naturally present in all sewages, but probably it was increased by the sulphates from the pickling liquors. When the beds were found to be in this condition the application of sewage was suspended, thus affording an opportunity for oxidation to take place in the beds. This resulted in oxidizing the sulphide of iron and changing the color from the black to the normal brown of the sand. This oxidation doubtless resulted in the formation of small quantities of relatively concentrated sulphuric acid, which may have been responsible for the action upon the concrete.

Whatever may have been the cause of the chemical action upon the cement-concrete pipe, it is important to recognize that conditions were such as to cause destructive chemical action. If the action was due to acids originally present in the sewage, it is worthy of note that the acid was present in sufficient quantity to offset the natural alkalinity of the sewage, as well as that contributed by industrial wastes such as that from the tanneries; and yet was present in extremely small quantities expressed in parts per million or percentages.

Standard Specifications for Cast-Iron Pipe

Although standard specifications of the New England and American Waterworks Association for water mains have been used for a number of years, the American Engineering Standards Committee believes that much remains to be done in standardizing specifications for cast-iron pipe for other uses, and at a meeting on October 4th attended by representatives of many users as well as by the Committee it was decided that it should endeavor to obtain further action along these lines. Specifications were submitted by the American Gas Association, the American Society for Testing Materials and others. It was

decided to authorize the chairman of the A. E. S. C. to call a conference on the subject which would consider soil pipe and other light types of cast-iron pipe as well as pipe flanges and fittings for high pressure work. The Committee decided that it was desirable that the subject be considered by a committee fully representative of all those having an interest in it.

The committee referred to was broadly representative, those present and the group represented by each being as follows: S. G. Flagg, Jr., American Society of Mechanical Engineers; F. A. Barbour, American Waterworks Association; F. A. McInnes, New England Waterworks Association; A. H. Hall and W. Forstall, American Gas Association; F. F. Schauer, Natural Gas Association of America; C. D. Young, American Society for Testing Materials; R. Toensfeldt, American Society for Municipal Improvements; H. Kelly, Associated General Contractors of America; J. C. Meloon, National Automatic Sprinkler Association; E. A. Barrier, Fire Protection Group; A. W. Claussen, Underwriters Laboratories; and W. G. Hammerstrom, N. F. S. Russell and W. Wood, representing foundry companies.

The A. S. M. I. Convention

Business proceedings, papers read, and discussions thereof at the annual convention in Atlanta, Georgia, last month. Membership increased during the year and finances in better condition.

Owing probably to the distance from the northern and north central sections of the country, where the majority of the membership of the American Society for Municipal Improvements is located, and partly, perhaps, to the change made during the year in the place of convention, the attendance at the Atlanta, Georgia, convention November 13 to 16 was not as great as that at most of the recent conventions, there having registered about 90 active members and 60 associate members. The meetings, however, were well attended and the officials and citizens of Atlanta seemed to take more real interest in the enjoyment and entertainment of those present than have several of the cities where the conventions have been held recently.

The business of the convention opened with the meeting of several of the specifications committees in the afternoon and evening of Monday, and the meeting of the Executive Committee. The only business of importance reported by the Executive Committee was the recommendation (which was later approved by the convention) that the constitution be so changed as to place the selection of the place of meeting for future conventions in the hands of the Executive Committee, the decision to be made and announced to the membership not later than the first of April immediately preceding the convention. This recommended change from the practice of naming places of meeting from the floor or of deciding by vote of the convention on a report from a special committee will be submitted to letter-ballot of the membership. The Executive Committee at this meeting admitted 23 applicants for active membership, 11 for associate and 4 for affiliated.

On Wednesday the Nominating Committee presented its report, placing in nomination the following: For president, E. R. Dutton of Minneapolis; first vice-president, E. L. Dalton of Dallas; second vice-president, T. Chalkley Hatton of Milwaukee; third vice-president, C. A. Poole of Rochester; finance committee, William A. Hansell, Jr., of Atlanta, George F. Fiske of Buffalo and G. J. Requardt of Baltimore. These were unanimously elected to the several positions.

TUESDAY SESSIONS

The formal meetings of the convention opened at 10 o'clock Tuesday morning with an address of welcome by Mayor Walter A. Sims, a response by First Vice-President E. R. Dutton, and the annual address by the president, W. W. Horner. Two of the points emphasized in Mr. Horner's address were a recommendation that this society co-operate with other societies where such joint action would seem to be profitable, and that one of the matters on which such joint action seemed desirable was that of a more equitable and wise form of contract for public work.

Following the report of the Executive Committee narrating the actions above referred to, and also the fact that the Executive Committee approved of the action of a committee of the society in agreeing upon a reduction of the number of sizes of brick and of varieties of asphalt which will be recognized as standard, the secretary read his report. The figures covering membership showed that of the active members 73 had been lost during the year and 94 admitted, leaving 521 on October 1; 9 affiliated members had been lost and 7 admitted, leaving a total of 30; 25 associate members had been lost and 20 admitted, leaving a total of 126; the net gain of all classes of membership during the year having been 14 and the total membership on October 1, 677. The secretary's financial report showed that $3,238 had been received as dues from active members, $187 from affiliated members and $1,436 from associate members; $389 from sale of proceedings, $13 from sale of specifications and $516 from advertisements; while $46.46 had been re-

ceived as interest on bonds and bank deposit. In order to meet a deficiency in finances of the previous year $500 of Liberty Bonds had been sold. Disbursements had amounted to $6,433. There was a balance of about $45 in bank and $1,000 in Liberty Bonds. Of the disbursements, the cost of the convention had been $1,213; publishing proceedings, $3,524; office, clerical and miscellaneous, $1,213; secretary's salary, $300, and $110 for expenses of committee and officers.

Committees on Nominations and Resolutions were appointed and the proposed amendment to the constitution was introduced.

The Committee on Public Safety reported through Mr. Becker, in the absence of Chairman Chaussé, that it was at work upon a report that would be ready at the next convention. For the Committee on Public Welfare, Jefferson C. Grinnalds reported that the committee had decided upon the plan of dividing the subject assigned to it into five heads and devoting one year to each of these during a 5-year cycle. H. F. Bascom had reported last year on "Baths and Comfort Stations" and this year the subject of "Markets" was reported upon. Mr. Grinnalds expressed the opinion that the location of markets was one that should be considered by city planners as a subject that was decidedly within their province. The market should be located in a local business district, but not on the highest priced land. Several members discussed the report; St. Louis, Baltimore, Allentown and others reporting that farmers took advantage of the markets for the sale of personally grown produce, those in Allentown, however, using private lots for their market stands. E. A. Fisher stated that in Rochester the markets were used almost exclusively for wholesale rather than retail business.

The afternoon session opened with the report of the Committee on Waterworks written by George W. Fuller and in his absence read by the secretary. This report gave briefly a review of recent developments in this branch of public utilities. A paper by John R. Baylis, entitled "Let Us Have More Palatable Drinking Water," was read by the secretary, the principal point made by Mr. Baylis being that, as the public has become more particular in its food, streets and all other features of modern life, it is entitled to be more particular in its water also, and that not merely as to its safety but also to its palatableness and general agreeableness. A paper describing "The New Water Supply Works at Memphis, Tennessee," whose author, J. R. McClintock, also was absent, was read by F. G. Cunningham. This described in detail the plans for extending the use of well water in this city and treating it so as to make it more wholesome, less hard, etc. Harrison P. Eddy discussed "Possible Causes of Failure of Cement Concrete Pipe Used for Under Drains in Sand Filters at Worcester, Massachusetts." This and the previous paper will be found elsewhere in this issue. There was no discussion of any of these papers.

In order to accommodate the author, Robert Whitten, his paper, entitled "Zoning Plans for Atlanta," which was down for Friday morning, was read at this session and was discussed by Messrs. Horner, C. C. Brown and others. Mr. Grinnalds stated that the planning in Baltimore provided for race segregation, certain sections being assigned exclusively for whites and other sections exclusively for negroes. The legality of this had not yet been passed upon by the courts, but as restrictions were placed upon each race from encroaching upon the districts set aside for the other and there was no unjust discrimination as to the topographical desirability of the assigned districts, he did not see why it should not be held as legal.

Two moving pictures concluded the session, one showing "How Bridgeport, Connecticut, Salvages Its Wornout Pavements" and the other showing at great length the manufacture and various uses of fire clay products. The former, by the Texas Company, showed the placing of a 3-inch asphalt wearing surface on an old macadam pavement, 140,000 sqare yards having been laid in 140 days by four gangs of men.

WEDNESDAY'S SESSION

Wednesday morning's session opened with the report of the Committee on Street Lighting, read by Ralph Toensfeldt, chairman. This was a general explanation of recent progress and was followed by two papers on street lighting, one by L. A. S. Wood of the Westinghouse Electric and Manufacturing Company and the other by Stephen Carleton Rogers of the General Electric Company. Mr. Wood described and exhibited the most recent device in connection with a street light unit, the asymmetric refractor, the first installation of which in Chicago was to be put into service on Thanksgiving. This he considered to be the greatest advance in street lighting made in years. Its purpose is to direct a very large percentage of the light in directions up and down the street rather than sideways toward the buildings. In the discussion of street lighting which followed the matter of elevation of light was considered, Mr. Wood recommending from 18 to 22 feet and Mr. Rogers stating that Boston had reduced the elevation of its lighting units from 28 feet to 18 feet. Mr. Grinnalds called attention to the correlation between city planning and street lighting. Referring to magnetite arcs, one member stated that although the current cost for these was less than for incandescent, they cost more for installation and upkeep, and, because of the necessity for a housing of the mechanism, were less susceptible to artistic treatment. Incidentally it was stated that St. Louis is intending to invest $8,000,000 in a new street lighting system.

"Street Lighting Distribution With Purchased Current," prepared by J. D. Bowles, was read by the secretary, in discussing which Mr. Toensfeldt stated that the electric power company in St. Louis prefers to sell the current only and not to furnish the street lighting system, believing that it is more satisfactory for both the city and the company that the former have the lighting system in charge.

The session concluded with an address on "Transportation Problems," by J. D. McCartney, assistant to the president of the Central of Georgia Railroad.

THURSDAY SESSIONS

On Thursday morning E. R. Conant as chairman read the report of the Committee on Street Paving and Street Design, following which, papers on paving subjects were read and discussed. These included: "Widening of Highway Curves," by G. A. Crayton; "Methods of Highway Construction in Georgia," by W. R. Neel; "Relation of Depth of Foundations to Their Strength," by C. D. Pollock; "Some Details in Street Design," by P. L. Brockway; "Modern Construction of Brick Pavements and Why," by Will P. Blair; and "Lime Rock Asphalts of the South," by E. A. Kingsley. Mr. Neel discussed chiefly sand clay roads and their maintenance, this being the type of road most common in Georgia. It is found serviceable under all except the more extreme traffic conditions, one road near Spartanburg carrying a thousand vehicles a day. An instance was cited of a top soil road which had for an unknown period carried traffic over an opening 5 feet wide by 8 feet long where the soil had settled away from the pavement, leaving it to span the depression as a bridge.

Mr. Pollock recommended the substitution, on a clay foundation, of coarse material for additional thickness of concrete base. This paper will be published in this or a following issue. The suggestion of progressive construction of a pavement made by Mr. Brockway was favorably commented on by several members, Mr. Horner stating that he had in one case laid a temporary pavement in a new street knowing that any pavement no matter how good would be cut up by traffic, house connections, etc., while the street was building up, this pavement to be replaced later with a more durable one. In another instance where a street railroad track was to be laid a temporary pavement was placed down the center of the street. Mr. Blair explained why the N. P. B. M. A. had changed its recommendation for filler from cement grout to bituminous.

Thursday afternoon was devoted to reports of specifications committees. F. P. Smith presented some minor changes, chiefly improvements in expression and the addition of definite clauses, in the specifications for bituminous pavements. No changes were recommended in the specifications for brick pavements. George F. Fiske, chairman, stated that a questionnaire relative to the preference between 1:2 grout and 1:3 showed the vote almost equally divided. R. A. MacGregor presented the report of the Committee on Specifications for Stone Block Pavements and John Klorer that of the Committee on Specifications for Wood Block Pavements. The latter recommended the omission of provisions for a sand cushion and the insertion of one for paint coat. E. S. Rankin, chairman of the Committee on Specifications for Sewers, presented a report recommending an important change whereby two divisions of the specifications, one providing for lump sum bidding and the other for unit cost bidding, should be combined, alternative clauses being given under each heading instead of two separate sets of specifications.

Following these reports, a paper by L. M. Fisher, entitled "The Engineer's Responsibility in Fostering Malaria Prevalence," was read by the secretary. This called attention to the various pools and larger bodies of stagnant water caused by embankments for roads, railways, etc., as mosquito breeding places. In discussing this, Mr. Blair recommended the substitution of pipe drains for open drains along highways, since the latter were too often obstructed with vegetation, dirt washed in, etc., and the water pooled up thereby not only bred mosquitoes but kept the subgrade moist.

SEWERAGE AND REFUSE DISPOSAL

Thursday evening's session was devoted to sewerage and refuse disposal. Mr. Hatton presented the report of the Sub-Committee on Sewage Disposal on investigations conducted by various cities and other agencies, including a progress report on the investigations by the city of Milwaukee on the fertilizing value of activated sludge. The main part of the paper was practically the same as the report made in October to the American Public Health Association by a committee whose personnel was practically the same as this, which report was published in the November issue of PUBLIC WORKS." An abstract of the investigation on the fertilizing value of activated sludge will be published in a later issue of this paper. Discussing this subject, Mr. Eddy stated that use of sludge as fertilizer must be, for each city, a local problem and must be accomplished largely through local propaganda. A. C. Decker described methods employed in "Night Soil Disposal at Mining Camps," especially one which consisted in depositing this in tanks and applying water so as to provide the conditions necessary for digestion. Mr. Eddy, in discussion of this paper, stated that this was the only case of which he knew of deliberately making sewage out of night soil, although of course there were numerous instances of dumping night soil into sewers. M. B. Tark referred to the process as essentially one of slude digestion, with which opinion others agreed. The necessity of water to secure digestion was illustrated by Mr. Hommon by citing cases of the army camps in which sludge was buried while wet but without the addition of any other water, and no digestion whatever took place. Mr. Hazelhurst expressed the opinion that the can system would always be desirable in most cities, for the sewerage system could not keep pace with the extension of residence districts into the outskirts of the city.

The most recent developments in connection with the use of the Maclachlan process of sewage treatment at Houston, Texas, were described by J. C. McVea. A final process and apparatus therefor had not yet been evolved, but the experi-

ments appeared to be very promising for ultimate success.

A report by Samuel A. Greeley on "Garbage Disposal in Various Cities" was read by Mr. Poole.

FRIDAY'S SESSION

The concluding session Friday morning opened with the reading of a paper, entitled "Recent Observations on Sewage Disposal Works in Europe," by George W. Fuller, in which he told of conditions in England, Germany and other European countries. Discussing this, Mr. Hatton called attention to the fact that activated sludge appeared to be finding favor with the smaller cities and towns in England; also that the English were not utilizing sludge, although this would appear to be very desirable for the communities of that country. He also referred to tests made of mechanical agitation at Pasadena and expressed the opinion that this method of aeration may prove advantageous for small plants.

W. W. Pollock described "The Valuation of Property for Taxation Purposes" as performed by the Manufacturers' Appraisal Company. G. J. Requardt described "How Baltimore Passed Its Zoning Ordinance," which was followed by a discussion on zoning in which E. A. Fisher expressed the opinion that provision for granting exceptions was an essential element of satisfactory zoning; and Mr. Hatton stated that within the two weeks previous the Wisconsin Supreme Court had handed down a decision upholding the powers of cities to enforce zoning under the police law, thus eliminating the necessity of a state enabling act. In spite of this, however, both Mr. Grinnalds and Mr. Fisher believed that a state enabling act was very desirable. J. E. Barlow, chairman of the Committee on Municipal Legislation and Finance, reported that that committee had been doing considerable work but had no report ready.

The session concluded with reports from representatives of the society in other organizations, including committees C-3 and C-4 of the American Society for Testing Materials, by George F. Fiske and E. S. Rankin, respectively; by A. W. Dow of the Sub-Committee of the American Engineering Standard Committee on Penetration for Bituminous materials; and by G. F. Fiske of the Paving Brick Committee of the Division of Simplified Practice of the U. S. Department of Commerce.

Road Builders' Convention and Good Roads Show

Why everyone interested in highways should be in Chicago during January 14 to 18. The show and the program of the Convention. Where to stop and what to do.

The twenty-first annual convention of the American Road Builders' Association and the fifteenth annual Good Roads Show will be held at Chicago, the convention at Congress Hotel January 15 to 17, and the show at the Coliseum January 14 to 18.

The value of these conventions to contractors and engineers is indicated by the following statements by H. B. Sproul, president of the H. B. Sproul Construction Company of Peekskill, N. Y., and Scranton, Pa., and P. H. Piepmeier, chief engineer of the Missouri State Highway Commission. Mr. Sproul says:

"I attended last year's Road Show at Chicago and am going again if my health will permit. Last year I was accompanied by General Superintendent H. M. Unangst, and we considered the time and money spent was the best investment we ever made as we were able to study different machinery and make a comparison with the different units right before us. We would not miss this year's show for the world."

Mr. Piepmeier says:

"I expect to arrange, if possible, for members of the Commission as well as a few of the engineers from this department to attend the Road Builders' Association meeting in Chicago in January.

"It is needless to say that I am making full plans to be present, as I do not recall having missed a single meeting in the last ten years. My purpose in having the Commission and engineers attend this meeting is that they may acquaint themselves with all modern equipment that is on the market suitable for road construction and maintenance.

"The Convention offers an opportunity for engineers and contractors to study and compare different types of machinery. It further offers an opportunity to meet engineers and contractors who are interested in various phases of road work.

"The program given in connection with the exhibit has always been of the highest class and much favorable information can be obtained from the papers, talks and discussions offered."

THE ROAD SHOW

The manufacturers of machinery for building and maintaining roads and the producers of road materials take advantage of the Show to display the latest types of road machinery, equipment and materials. The man who attends the 1924 Good Road Show will have a chance to see every new piece of road building equipment that will be at work on the highways of the country next year. Most of the exhibitors at the Road Show bring their men to Chicago from all parts of the country for the Show, and it is possible to meet there nearly every one identified with the distribution of road building equipment and materials.

THE CONVENTION

The following is the official program of the convention:

OPENING SESSION TUESDAY MORNING, JAN. 15, 10 A. M.

Chairman—Frank Page, President, American Road Builders' Association.

President's Address, by Frank Page, Chairman State Highway Commission of North Carolina, Raleigh, N. C.

Highway Improvement a Continuing Business, by Thomas H. MacDonald, Chief, Bureau of Public Roads, Washington, D. C.

MATERIALS AND DESIGN. TUESDAY AFTERNOON, JAN. 15, 2 P. M.

Chairman—S. L. Squire, Deputy Minister of Highways, Ontario, Toronto, Ont.

Recent Development of Bituminous Base and Sand-Asphalt Road Construction, by E. R. Olbrich, National Research Council, Washington, D. C.

Outstanding Problems in Highway Bridge Design—Surface, Width, Vulnerability, Ground Plan, by E. F. Kelley, Senior Highway Bridge Engineer, Bureau of Public Roads, Washington, D. C.

Smoothness as a Factor in Pavement Life, by A. T. Goldbeck, Chief Division of Tests, Bureau of Public Roads, Washington, D. C.

TRAFFIC AND MAINTENANCE. WEDNESDAY MORNING, JAN. 16, 10 A. M.

Chairman—R. Keith Compton, Chairman Paving Commission, Baltimore, Md.

Traffic Surveys—Methods and Costs, by H. E. Hamlin, Superintendent of Repairs, Connecticut State Highway Commission, Hartford, Conn.

Traffic Surveys—Findings and Deductions and Their Lesson for the Road Engineer, by J. G. Mackay, Bureau of Public Roads, Washington, D. C.

Snow Removal—Organization, Methods and Equipment, by Edward E. Reed, Assistant State Highway Engineer, New Jersey State Highway Commission, Trenton, N. J.

Central Plant Maintenance—Possibilities for Large Concentrated Mileages, by Leroy C. Smith, Engineer Manager, County Road Commissioners, Wayne County, Detroit, Mich.

Highway Traffic Accidents—Classifications and Causes, by N. M. Isabella, Assistant Maintenance Engineer, Wisconsin Highway Commission, Madison, Wisc.

ADMINISTRATION. WEDNESDAY AFTERNOON, JAN. 16, 2 P. M.

Chairman—Frank Page, President American Road Builders' Association.

State Cement Manufacture a Highway Administration Policy:

(1) *Merchandising and Transport Conditions Which Prompted Consideration of State Purchase and Manufacture of Cement Road Building Materials,* by B. F. Piepmeier, State Highway Engineer of Missouri, Jefferson City, Mo.

(2) *State Purchase and Storage as a Means of Regulating Cement Supply and Price Without State Manufacture,* by C. N. Connor, Construction Engineer, North Carolina State Highway Commission, Raleigh, N. C.

Election of Officers.

Business Session

JOINT SESSION WITH ASSOCIATED GENERAL CONTRACTORS

THURSDAY MORNING, JAN. 17, 10 A. M.

There will be a joint session with the Associated General Contractors, which will be held on Thursday, Jan. 17th, when the presiding officer will be John W. Cowper, president of the Associated General Contractors of America. Mr. Cowper's reasons for arranging this joint session are set forth in the following letter:

"As President of the Associated General Contractors, I was very much interested in setting the date of our annual convention to concur with and immediately follow the Road Show because I believed it would be of the greatest interest to a great many, if not all, of our members to see the exhibit which you put on

"I have attended one show and then only for a very few minutes but sufficiently long to gain a very excellent impression of what benefits a contractor, whether he be in the road building game or some other line of construction, can get from a visit to this show.

"I expect personally to spend considerable time looking over the Road Show Exhibit and confidently count on a great deal of personal benefit that will react in my business to our good and I look forward to great success from holding our Contractors' meeting concurrently with yours."

The program of this joint session is as follows:

Chairman—John W. Cowper, President, Associated General Contractors of America, Buffalo, New York.

Purpose and Progress of Equipment Standardization, by C. E. Bement, President Novo Engine Co., Lansing, Mich.

Standard Highway Contracts a Public Service, by General R. C. Marshall, Jr., General Manager, Associated General Contractors of America, Washington, D. C.

Economic Aspects of Day Labor Construction, by Arthur S. Bent, Bent Brothers, Los Angeles, California.

Bonds as a Gauge of Responsibility, by H. H. Wilson, Managing Partner, Winston & Co., Harrisburg, Pa.

CONSTRUCTION. THURSDAY AFTERNOON, JAN. 17, 2 P. M.

Chairman—Frank Page, President American Road Builders' Association.

Can We Cut Down the Curing Period for Concrete Roads, by H. F. Clemmer, Testing Engineer, Illinois Division of Highways, Springfield, Ill.

Simplified Practice a Service to Industry, by R. M. Hudson, Division of Simplified Practice, Department of Commerce, Washington, D. C.

Controlling the Distant Units in a Highway Construction Organization, by O. M. Kipp, Construction Engineer, Minnesota Highway Department, St. Paul, Minn.

REGISTRATION

Registration blanks have been printed in the form of tickets of admission which are to be filled out and presented at the entrance to the Road Show, in exchange for which the individual will receive a badge which will admit him to the Road Show at any time.

No admission is charged to the Road Show. No one will be admitted, however, until he fills out and presents a registration blank to get his badge.

Registration blanks may be obtained at the entrance to the Coliseum. They also will be mailed free on application by mail to the American Road Builders' Association, 37 West 39th Street, New York City. Exhibitors have agreed to help distribute them through their field organizations.

This plan of registration should insure that all may be listed without any delay or inconvenience.

HOTELS

While Chicago has abundance of good hotels, all who expect to attend the convention should write at once and make reservations. The following hotels are recommended by the Chicago Association of Commerce, which also maintains a Bureau which may be called up in case a room can not be obtained in the hotel selected, the telephone number of the Bureau being Main 4808.

The hotels are classified below according to the prices charged. Any one may be reached by addressing it at Chicago, Ill.

From $1.25 Up—Bradley, Briggs, Colonial.

From $1.50 Up—Alexandria, Bismarck, Darlington, Gladstone, Grant, Hayes, Lakota, Metropole, New Gault, New

Southern, Stock Yard Inn, Strand, Victoria, Windsor Clifton.

From $2.00 Up—Atlantic, Board of Trade, Brevoort, Drexel Arms, Elms, Fort Dearborn, Great Northern, La Salle, Lexington, Luzerne, Majestic, Palmer House, Parkway, Plantus, Plaza, Plymouth, Sherman, Trenier, Washington.

From $2.50 Up—Auditorium, Del Prado, Hyde Park, Lorraine, Moraine, Morrison, Sheridan Plaza, Virginia.

From $3.00 Up—Chicago Beach, Congress Hotel and Annex, Edgewater Beach, Grasmere, Jackson Park Tavern, Melbourne.

From $3.50 Up—Ambassador, Cooper-Carleton.

From $4.00 Up—Drake, Somerset, Sovereign, Webster.

From $5.00 Up—Blackstone, Sisson, Windemere.

From $10 Per Week Up—Montezuma Lodge.

GET CERTIFICATES FOR REDUCED FARES

The various railway passenger associations covering the United States and Canada have granted a special reduced rate under the "Certificate Plan" of one and one-half fares for the round trip, covering all points in their territory to and from Chicago. The reduced fare is available not only for members of the American Road Builders' Association and delegates ot the congress but also for dependent members of their families. In order that they may profit by the reduced fare, delegates are urged to carry out the following directions:

Be sure to get from the railroad ticket agent a "convention certificate" when purchasing your going ticket. Immediately on arrival in Chicago present this to the Secretary at the convention, E. A. Birchland, who will endorse it and have it validated by a joint agent of the various railways. Unless so validated you can not obtain a fifty per cent reduction in the cost of your return ticket.

Snow Cleaning Appliances

A questionnaire on street-cleaning was submitted a few weeks ago to a number of cities, and replies from over 100 gave the kind of appliances used by them in removing snow from their streets. These replies were published in the September issue. Summarizing these replies and grouping them with respect to the appliances used, we find the following results:

Shovels were reported used by 37 cities, hand scoops by 1, "hand removal" by 1 and brooms by 2. Undoubtedly a number of cities also used hand labor which did not report it directly but stated that the snow was removed in trucks, wagons, etc., into which it was, in the majority of cases, thrown by hand. One city, however, reported the use of a snow loader and two reported steam shovels.

For removing snow from the streets, 51 reported using trucks and 54 used horse-drawn vehicles, which were reported in 23 cases to be wagons, in 9 cases carts and in 5 cases sleighs.

Fifty-three reported the use of plows, 5 specifying that they were attached to trucks, 2 to trolleys, 1 to a tractor and 5 that were horse-drawn. Graders or scrapers were reported for snow removal in 1 city and hose in 2 cities. A few replies that did not definitely specify the appliances used were: trolley cars, 2; tractors, 16; auto carts, 1; buckboards, 1, and large scoops, 1.

The use of snow-cleaning machinery has increased rapidly during the past few years, even more so on the highways than in cities, and indications are that the use will become even more general the coming winter. Several new appliances have recently been placed upon the market and are described in the department of "New Appliances" in this issue.

Missouri Concrete Pavement Cross-Sections

The chief engineer of the State Highway Department of Missouri, B. H. Piepmeier, announced on Dec. 3rd that the Department had changed its standard cross-section for concrete pavement from a uniform 7-inch thickness to uniform 6-inches except that the edges are to be 9 inches tapered back to 6 inches at 2 feet from the edge. The use of longitudinal steel along the edge of the pavement and the center joint will be continued. Contractors are specially notified that these dimensions are the minimum and any deviations must result in making the pavement thicker rather than thinner.

It is suggested to contractors that those who have been using 7-inch steel side forms may use these for the new-cross-section by attaching a 2x6 plank securely to the base; but suggests that if new forms be purchased, the 9-in. size be obtained, since Mr. Piepmeier assures the contractor that the Department "will confine all its paving work for the next few years, at least, to a 9-inch edge."

Self-Purification of Rivers

One of the most important papers presented before the Sanitary Engineering Section of the American Public Health Association at the recent Boston meeting was that by Surgeon W. H. Frost of the U. S. Public Health Service, in which he reported the progress made in studying the self-purification of the Ohio and Illinois rivers. It was believed that the degree of that class of pollution of the river that was being studied was best expressed by the number of B. coli per c.c. in the river water. Numerous determinations were made at different points below sources of gross pollution and, taking the averages at the several points, a curve was plotted using the numbers of B. coli as ordinates and the time in hours from a point of maximum pollution as abscissas. The curves so obtained were remarkably similar, both for the two rivers and also for summer and winter groupings. In each case the reduction in numbers was rapid, but the rate decreased and the curve approached the horizontal or zero axis after about 80 hours' flow. This showed plainly the great length of time necessary to restore to its previous condition a stream that has been greatly polluted. Of course there were considerable variations from the curve in individual counts, but not sufficient to throw any doubts upon the conclusion.

Foundation Excavation for Bronx Market

In constructing the foundation for a market at 152nd street and Exterior street, New York City, known as the "Bronx Terminal Market," H. P. Converse of Boston, who is contractor for the large foundation piers, is using ten derricks, finding economy in utilizing these in a systematic manner. Of the ten derricks about half of them only are doing bucket duty at a time, the other half being engaged in other work connected with the contract. The rotation of operation is as follows: Derricks using Blaw-Knox clamshell buckets of the "dreadnought" type first excavate the material from the pier holes and load it directly into trucks without rehandling, this being made possible by the proper spotting of the derricks. These derricks average about 900 cubic yards of excavated material a day. The material being excavated is a tough, sticky clay, but the clamshells are found to fill at every bite and to empty themselves readily.

The derricks then put the piles in place and drive them with a pile driver. Following this, they are used to place the sheathing and to drive it with pile drivers. This completes the work preliminary to mixing and placing the concrete for the foundation piers.

Derrick as Dragline

In recent construction work on the Wanaque dam a stiff-leg derrick has been used as cableway and drag-line excavator, by an arrangement devised by Ralph Young, superintendent for the contractor, W. H. Gahagan, Inc. Its use as a cableway is described for us by Frank C. Sellnow, senior assistant engineer on the work, as follows:

"In the excavation of earth and rock for the stream control conduit, a portion of the Wanaque dam under construction by the North Jersey District Water Supply Commission, novel use

STIFF-LEG DERRICK USED AS A CABLEWAY
Bucket of material at left being transported to dump cars between it and the derrick.

is being made of a stiff-leg derrick which had been employed in the construction of the corewall; briefly, it is being used as a cableway. The closing line is guyed to a tree or a bar secured in the rock and the dump bucket, suspended from a sheave block running on the closing line, can be pulled back by the lifting line, lowered and dumped in the 4 cu. yd. cars. When emptied, the closing line is tightened and when the bucket has been raised to a point where it will run back by gravity, the lifting line is slowly payed out until the bucket has been trolleyed back to the point of loading. If it is desired to swing the boom of the derrick in the event the cars are not directly under the cableway, this can be done as soon as all the load has been transferred to the lifting line."

As it is being used at this writing, the excavated material is loaded into buckets or skips which are carried across the river (shown at the left of the photograph) on the cableway. Most of the excavation now is rock, but in removing the overburden a drag-line bucket was used, the closing line being used as above and the lifting line used as a drag line.

EXCAVATING FOR FOUNDATION PIERS OF BRONX TERMINAL MARKET.

The Automobile and City Planning

Traffic congestion, of which the automobile is the chief cause, calls for planning of city streets with a view to relieving it.

By Alvan Macauley *

It is becoming unmistakably clear to the automobile industry that, particularly in the larger cities, it is faced with a new kind of "saturation point." While it has been discussing what the *buying* limit may prove to be, it is suddenly finding itself confronted with a *using* limit. Traffic congestion has already begun to inhibit the use of automobiles.

The phases of this same problem which affect the public at large, however, are even more important. These include the increasing number of traffic accidents, the effect of the automobile in decentralization of population, recreation facilities, transportation, and others. All of these are problems which can and must be solved to a large extent by the city planner.

That the automobile industry recognizes the relation between these problems and city planning is indicated by the fact that, at the recent closed car show in New York, there was a city planning exhibit with its charts, maps and models setting forth the city planning problems presented by modern traffic conditions.

The automobile did not make this traffic problem, although it may have expedited it. If a traffic even approximating in volume that now existent were dependent upon horse-drawn vehicles for handling it instead of the much more rapid automobile, the street congestion would be much greater even than it is.

Probably everyone realizes that there is a traffic problem, but few, even of the public officials, clearly realize that the problem lies in the street and not in the automobile. Traffic ordinances, traffic regulations, policing, mechanical devices, safety campaigns—all these are essential, urgent. But they are palliatives, not solutions. They require and should receive thought, public energy, cooperation and money, but should not divert these from the more fundamental city planning.

Possibly no solution of the traffic problem is practicable in the case of the great metropolitan cities. For the metropolitan cites of the near and far future, however, a solution is still possible; but it will be found in the drafting room and not in the courtroom.

The need of city planning is now commonly accepted, but the need of an application of its principles to the traffic problem is not so generally realized. What is needed now is the active cooperation of the automobile industry in the engineering solution of traffic problems through the proper designing of streets and street plans.

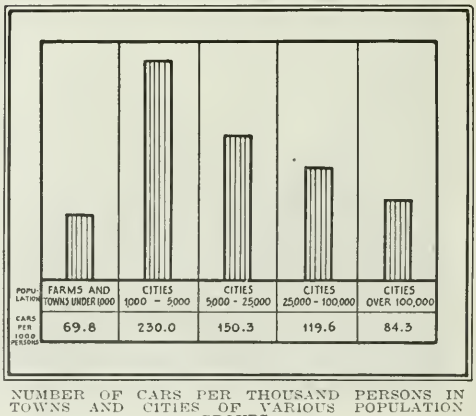
The problem in cities of over a million population must be left to traffic regulation experts and developers of huge projects of street-widening, elevated roadways and other changes involving millions. For the smaller cities, however, there is hope in a cooperative solution of the city planning problems presented, or, rather, in preventing the development of such problems.

In 1920 there were 43 cities having populations between 100,000 and 250,000, 13 with populations between 250,000 and 500,000, 9 between 500,000 and 1,000,000, and 3 with over 1,000,000 population. The following table shows the motor vehicle density (that is, the number of motor vehicles per square mile of area) of the 12 of these 68 cities which lead in this respect; also their present population and approximately the year in which they passed the 100,000 mark.

City	Motor Vehicles per sq. mi.	Population	Year Population Passed 100,000
Dayton, Ohio	1,885	152,559	1905
Detroit, Mich.	1,867	993,678	1876
San Francisco, Calif.	1,803	506,676	1865
Cleveland, Ohio	1,762	796,841	1871
Reading, Pa.	1,704	107,784	1914
Dallas, Tex.	1,695	158,976	1911
Milwaukee, Wis.	1,471	457,147	1877
Toledo, Ohio	1,454	243,164	1894
Akron, Ohio	1,448	208,435	1914
Bridgeport, Conn.	1,337	143,355	1909
Rochester, N. Y.	1,318	295,750	1882

Motor vehicle density is by no means a matter of number of automobiles in a city or even the ratio between automobiles and population. The 12 cities of the 68 which lead in number of persons per motor vehicle are: Los Angeles, Salt Lake City, each 3; Dallas and Houston, each 4; and 5 in the case of Indianapolis, Kansas City, Minneapolis, Seattle, Spokane, Syracuse, Toledo and Youngstown. It will be noticed that only Dallas and Toledo appear in both lists.

A most important fact shown by the vehicle density table is that, of the twelve cities named, seven have between 100,000 and 250,000 popula-



NUMBER OF CARS PER THOUSAND PERSONS IN TOWNS AND CITIES OF VARIOUS POPULATION GROUPS.

*President, Packard Motor Car Company.

tion, two between 250,000 and 500,000, three between 500,000 and 1,000,000, and none over 1,000,000. This shows that the traffic problem is developing most intensely in those cities having less than 1,000,000 population rather than in the largest ones, and that those of under 250,000 are in the most danger. Conditions will probably be worse in the "newer" cities, as in this list seven out of the twelve have passed the 100,000 mark since 1890, six of them since 1900, and four since 1910. It is probable that more attention to traffic control is being paid by cities of over 100,000 population than those under this figure, but out of forty cities leading in motor fatalities in 1922, only thirteen were over 100,000 in size, while two-thirds of the number were under this size.

That the traffic problem is not due to size of city, congestion of population or automobile ownership but rather to the inadequacy of the city streets is further proved by the accompanying chart. This shows that as the population of towns and cities increases, the density of automobile ownership decreases. Those towns having a population between 1,000 and 5,000 have 230.0 cars per 1,000 persons; those between 5,000 and 25,000 have 150.3 cars per 1,000 persons; those in the 25,000 to 100,000 group have 119.6 and those over 100,000 have 84.3. Further, it is surprising to find that the only section of the country where country use of cars is greater than city use is in the Middle Atlantic States, New York, Pennsylvania and New Jersey—states where concentrations of population are greatest. What serious problems will be faced by the larger cities when autmobile ownership reaches the proportions there which it has reached in the smaller towns?

The effect of the automobile upon this problem should be clearly visualized by the city planner, and his street plans should be designed and built as a system of automobile traffic ways. To this end he should study the increase of automobile ownership in his city, study traffic counts and traffic streams; forecast population centers and business centers, and, having made such forecasts, plan to eliminate traffic tangles and provide for parking.

Automobile owners are beginning to see the importance of city planning as they could not see it when they were only walking citizens. And the automobile industry will do its utmost to make the visions and necessities of city planning alive for the automobile owner.

Road Maintenance in Indiana

Accurate record of the cost of maintaining a section of Indiana state highway by use of a grader was kept by A. A. Davis, superintendent, for the four-week period from August 20 to September 15, 1923.

During this period the grader was operated 22 days and traveled 557 miles, used 289 gallons of kerosene at 12.2c. per gallon, 13¼ gallons of gasoline at 14.2c., 21 gallons of oil at 74.5c., ¼-pound cup grease and ½-gallon transmission oil. These items cost as follows:

Kerosene $35.26, gasoline $1.88, oil $15.65, cup grease 20c., transmission oil 50c. In addition, two blades were purchased costing $16. The operator was paid $4 a day or $88. This gives a total cost of operation of $157.49

Mr. Davis figures the depreciation at $25, giving a total cost of $182.49, or an average of $8.30 per day, or of 33c. per mile. The grader used in this instance was a Wehr grader.

Pennsylvania Highway Finances

In a recent statement, Paul D. Wright, secretary of the Pennsylvania Department of Highways, has given some figures concerning the financial situation of the Department of Highways, in connection with a plea for a vote on November 6th favorable to the $50,000,000 bond issue for highway construction.

He stated that the program for highway construction for 1923 and 1924, comprising 275 miles, will exhaust all money in sight and available for construction work unless the bond issue should pass, and that there was little prospect of receiving any more funds from legislative appropriations.

The vote on the bond issue was 624,297 for, and 237,543 against, or more than 2½ to 1 in favor. Of the 67 counties, only 3 voted against the bond issue. Pennsylvania therefore seems to be unquestionably "sold" on the importance of improved roads.

There is a considerable revenue derived from motor license fees and others, but these are all vitally needed for maintenance. The total of these revenues is estimated at $17,000,000. The maintenance requirements per year are estimated at $24,500,000, divided as follows:

1. General repairs—all classes—earth, stone, concrete, etc., and maintenance of equipment.	$4,850,000
2. The surface treatment of oil and chips to about 3,000 miles of stone road. This is necessary for the conservation of the investment in them and to keep them in travelable condition..	1,500,000
3. Extensive resurfacing with penetration macadam of waterbound macadam roads which are worn out and too light for the traffic demands	5,500,000
4. A long-time program of replacement of all these stone roads with a more durable type, such as concrete	5,000,000
5. Replacement of out-of-date and weak guard rail at dangerous locations by our present type of cable guard rail.	750,000
6. Widening of Lincoln Highway and other important roads to relieve dangerous curves and narrow conditions	550,000
7. Repairing and replacing bridges which may be too narrow or too light and unsafe for the traffic requirements	500,000
8. Maintenance of Borough Roads on State Highways	1,750,000
9. Township Reward, $1,000,000 a year appropriated of the motor license fees by the legislature	1,000,000
10. Elimination of grade crossings	1,500,000
11. Overhead on maintenance operations	1,600,000
Total	$24,500,000

Even should it be claimed that some of these items are not properly classed as maintenance, the fact remains that they are essential expenditures in that they are necessary to conserve former investments keep the roads in a travelable condition and provide for the safety of the users.

Tunnelling on the Skagit River Project

Hydro-electric power for Seattle, Washington, is being developed on the Skagit river at a point slightly over 100 miles from that city. The Skagit river is 150 miles long, with a drainage area of about 3,000 square miles. The upper third of the river with 1,200 square miles of drainage area is included in the power development now under way and the total power ultimately available will be 558,000 horsepower. Three projects are contemplated, known as the "Ruby," "Gorge" and "Newhalem," respectively. The first includes constructing a concrete dam of gravity section 480 feet high and 1,000 feet long, creating a reservoir 23 miles long, 1,600 feet above sea-level and with a capacity of 1,-300,000 acre-feet. Water from this reservoir will flow to the power house through a 28-foot tunnel 3¼ miles in length with a capacity of 6,000 cubic feet per second.

The Gorge reservoir will be formed by a gravity type concrete dam 240 feet high and 600 feet long. Water from this reservoir, which will back up to the Ruby tail race, will flow through two concrete-lined pressure tunnels with an excavated diameter of 23 feet 6 inches and a length of 11,000 feet, while three penstocks from these to the power house will be excavated through solid rock, steel-lined, 11 feet inside diameter.

The Newhalem development includes a timber crib diversion dam 4 feet high and a tunnel 2,680 feet long.

The voltage for transmission purposes over the 107 miles from the Ruby plant to Seattle will be 165,000 volts.

The entire project is under the direction of S. F. Uhtern, chief engineer of Skagit River Development, with A. J. Turner as engineer in charge of construction.

Tunnelling, it is seen, is one of the chief features of the several projects. The present tunnelling contract is being carried on by R. C. Storrie & Company of San Francisco, under the direct management of R. B. Muir and construction supervision of R. C. Hockley and R. Scott.

Tunnelling is done by the bench and heading method, the heading being about 7 feet by 18 feet. Usually about thirty drill holes, using a V type of cut holes, are employed in breaking an 8-foot round, and are loaded with about 200 pounds of Giant V. LF gelatin 60 per cent. 1-1/4x8. The bench is broken with about twenty holes about 18 feet deep loaded with about 300 pounds of Giant V. LF 40 per cent. and 60 per cent. 1-1/4x8.

In firing the rounds, Delay electric blasting caps are used connected in parallel and fired from a power line of 110 volts. The caps used in the heading are of series 1 to 8 with 10-foot wires, and those used in the bench rounds are series 1 to 10 with 20-foot wires.

Steam shovels are used for mucking and the muck trains are hauled by storage battery locomotives.

Some unique equipment has been designed for this work and built on the spot. Among others may be mentioned a drilling carriage mounted on two muck car trucks. This is of framed timber construction with a top platform nearly level with the heading floor, which facilitates the work on the bench and the transportation of drills and other material to and from the heading while the bench is being drilled. The drill bars are so designed as to fold back against the side of the car when the car is to be moved out. A lower platform may be used for extra equipment. All air, water and electric light connections are provided for on the car. With the bars in drilling position, four air drills can work simultaneously. This equipment is used in drilling the bench, 18-foot to 20-foot steel being used.

For the above information we are indebted to A. H. Clough, of the Giant Powder Company.

Air Map of New York

The aerial work of making a photographic map of New York City was completed in November and the mapping work is well advanced. About 625 square miles is included in the area surveyed, 2,000 exposures were necessary and 3,000 miles flown. The contract for the map was made with the Fairchild Aerial Camera Corporation on July 10, 1923, calling for the delivery of the map by April 15, 1924, and three planes have been over the city every good photographic day since the former date.

Two maps are being made, one at a scale of 600 feet to one inch covering 400 square miles within the official city limits, to be delivered in 140 sections, each about 14 x 21 inches. The other map is at a scale of 2,000 feet to one inch, covering 625 square miles, which includes, besides the city, parts of adjacent counties and of New Jersey, and will be made in one map 10 x 8 feet.

Fifteen engineers and surveyors are employed checking controls and assembling maps. If a negative shows a very small degree of tilt, this is corrected in the printing process. Also each print has to be brought to the required scale by enlargement or reduction, requiring a finely calibrated adjustment of the enlarging camera.

The map will show every structure in the city, fences, trees, crowds and roadway traffic—every physical feature, both animate and inanimate, that was not under cover at the time the photograph was taken. It can, therefore, be used for a variety of purposes by the different municipal departments and in investigations made for city planning, traffic control and many others.

Widening an Indiana Pavement

Owing, it is believed, to the example set by the Ideal Section of the Lincoln Highway, the Town Board of Dyer, Indiana, expects to construct two 11-foot strips of concrete pavement, one on each side of an existing 18-foot concrete road, extending from the western end of the Ideal Section to the Illinois State line, thus increasing the width of this road to 40 feet, the same as the Ideal Section itself.

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A. PRESCOTT FOLWELL, Editor

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The Road Convention and Show

Considerable space in this issue is devoted to conventions of the American Society for Municipal Improvements and the American Road Builders' Association. The former, held last month, was the annual meeting of that national society that devotes more attention than any other to municipal engineering, including city streets; while the latter will next month gather from all over the country engineers, contractors and public works officials who are interested in constructing and maintaining roads.

Road construction and maintenance leads all other branches of public works in amount of money spent and in number of engineers and contractors engaged on it. Also, it is the newest branch and that in which there is the most rapid growth in both science and practice. It is therefore evident that for engineers and contractors this convention of road builders and exhibition of machinery and appliances is the big event of the year. A highway contractor or engineer who misses it loses his annual opportunity of getting up to date on a subject that makes enormous advance even in the year between conventions.

At this convention, among other possibilities offered to engineers, is that of learning and discussing the latest results from tests conducted by federal and state authorities, as well as information derived from study of the action of roads in service, and contractors can learn the latest methods of handling materials and economizing in labor; while both can promote that mutual understanding of each other's viewpoints which is essential to the best results. At the show, contractors can see and examine machines, one or more of which may next year enable them to cut down their operating costs and change a loss to a profit, or to offset the impossibility of getting sufficient labor at reasonable wages by getting along without it.

It is the occasion of the year for highway men to know and become known.

Lighting Highways

A century or two ago city streets were unsafe for travel by night, either on foot or by vehicles, the only illumination being furnished by lanterns or torches carried by those using the streets. Highways are now in much the same condition, being illuminated at night only by the lights of the automobiles or other vehicles using them; and the result is far from satisfactory, for if the light is bright enough to render somewhat less dangerous a speed that would be comparatively safe in the daytime, the glare in the eyes of those driving approaching vehicles is so blinding as to invite collision. Moreover, the headlight often fails to reveal a turn in the road or other dangerous feature.

Highways are now more travelled by night than were city streets in the days before street lighting, and the reasons then calling for adequate lighting of streets now even more urgently demand the lighting of highways.

Nor is safety the only reason. In an article in

the November issue of Public Works dealing with street lighting it was stated that where streets that carry heavy traffic are adequately lighted they can be used at night, and this does much toward relieving congestion on them by day; and the lighting of roads would similarly tend to diminish day-time congestion.

The dangers and inconveniences of night travel on highways can be very largely removed by the use of lighting units that have recently become available, whereby sufficient illumination can be thrown upon the entire roadway to reveal clearly the edges of the pavement, any turns in the road, approaching vehicles, pedestrians, or other permanent features or temporary obstructions which it is desirable to avoid; the lighting units being so elevated above the road and the rays so directed as to reduce to a minimum the glare in the eyes of those driving the vehicles.

The model section of the Lincoln Highway included lighting as one of the features which it offered for imitation; and the considerable and increasing night use of the highways for pleasure riding, and the possibility of avoiding day congestion by continuing the use of the highways by commercial vehicles well into or through the night, offer arguments in favor of lighting that will undoubtedly result in the rapid adoption of this improvement on our busiest highways.

Unintelligent Bidding

Without knowing whether the lack of definiteness in the plans and specifications are to blame, or recklessness, carelessness or ignorance on the part of the bidders, bids received by the Sanitary District of Chicago last October showed such wide divergencies that it seems unquestionable that some of the bidders used poor judgment, either by bidding on plans that they did not understand, or in ignorance of even an approximation of what it would cost to do the work; or else some just jacked up their figures on the possibility of landing a fat thing.

The work consisted of 4,840 feet on a 6½-foot outfall sewer, with some minor appurtenances, and the bids ranged from $26 to $61 a lineal foot, four being below $35 and three above $50. Of the appurtenances, one was a junction chamber, bid at a lump sum, and the bids varied from $1,500 to $15,600, five bids being below $3,000 and three $7,000 and over. On another structure the bids ranged from $1,500 to $17,800.

Is contracting a legitimate business or just a gamble?

Winter Preparation for Highway Construction

On October 20 a highway of reinforced concrete between Schnecksville and Pleasant Corner, Pennsylvania, was opened with elaborate ceremonies, bands, hundreds of automobiles, etc. This stretch is about 4½ miles long, 16 feet wide, 7 inches thick at the center and 5 inches wide at the sides, reinforced with galvanized wire mesh weighing 65 pounds per hundred square feet. The grading consisted of 16,000 cubic yards of earth and shale, which was rough graded with a steam shovel. Because of springs and the flatness of the ground, 8,000 feet of drain tile was laid in and alongside the road for draining the subgrade. The road was built under state supervision but paid for entirely by Lehigh County, the cost being $170,000.

The contract was completed one month sooner than had been contemplated, which is probably to be attributed to the foresight of the contractor, the Juniata Company. The contract was awarded last winter and the contractor, anticipating scarcity of material in the busy summer season, hauled and stocked on the job in three large stock piles the entire amount of sand and stone necessary to complete the work, a considerable time before the opening of the working season. Work began on April 23. Sand and stone were elevated from the stock pile by conveyor into bins and delivered from the bins through measuring hoppers to trucks carrying five batches, and by them to the mixer. This road being in the center of the Pennsylvania cement manufacturing district, the cement was sent from the mill direct to the mixer. The work was in direct charge of W. W. McCray for the contractors.

University of Michigan Highway Teaching Facilities

The University of Michigan in 1919-20 offered the first course in highway transport to be given by an American educational institution, since which time ten others have been inaugurated. In 1923-24 25 courses in highway engineering and highway transport are being given by this university and the Board of Regents has established a Chair of Highway Engineering and Highway Transport and appointed a professor of this subject, an associate professor, assistant professor, instructor, three assistants and a librarian. By an arrangement with the State Highway Department all the testing of highway material for the State of Michigan is done in the university laboratory.

Because of the development of this course and the demand for additional facilities the Board of Regents has allotted 20,000 square feet of space for this division in the new engineering building which was opened for use at the beginning of the present college year. This space is divided up into various rooms for laboratory work, lecture rooms and offices of the teaching force.

Pennsylvania Transport Survey

The State Highway Department of Pennsylvania on November 8 began a motor transport survey of all the important roads of the State, in which it is receiving the co-operation of the United States Bureau of Roads. The information thus gained will be used in determining the width and thickness of pavements to be built in the future.

This transport survey is believed to be the most intensive ever undertaken. It involves the operation of 78 truck weighing stations and over 300 recording stations, so distributed over the primary and secondary roads of the State as to give the most accurate estimate obtainable of the

highway traffic. It is expected to continue it for an entire year. At each of these stations a sign will be placed calling upon all traffic to stop and to fill in cards giving the license number of the motor vehicle, the width and type of body, manufacturer, capacity both loaded and light, and weight.

Stream Line Filters

What is probably the latest novelty in the waterworks field was described by George W. Fuller in a paper read at the meeting on "Pollution of Streams by Industrial Wastes" held at the Engineers' Club of Philadelphia on October 16. This was a new kind of filter called "stream line filters" which are the invention of H. S. Hele-Shaw, last year president of the British Institution of Mechanical Engineers. He discovered the principle of the filter last winter while experimenting with lantern projections in a study of the behaviour of films under pressure. Announcement of the discovery was made before the Royal Society on May 10 of this year. A considerable interest has been shown in England in this discovery.

The stream line filter in its simplest form is made of a pack of specially prepared paper, impervious to water and oil and somewhat roughened to provide passage ways, the pack being held within a container between two press heads by means of which any desired pressure can be exerted upon the pack. Through the entire pack are two alternate sets of circular holes, the larger holes being for the influent and the smaller ones for the effluent. At one press head are channels through which the influent is lead to the larger openings and at the other pressure heads are channels connecting with the smaller openings for removing the effluent. The influent, even when introduced under heavy pressure, can pass from the larger openings to the smaller ones only through the laminae of the heavily compacted pieces of paper with a stream-like motion.

Such a filter requires cleaning at intervals, the frequency of which depends upon the quantity and quality of influent filtered. Cleaning may be done in one or both of two ways. Either the deposit on the walls of the influent tubular holes is pushed through suitable ports in the press head by means of light, free-fitting pistons which are actuated by the pressure normally used in pushing the effluent through the filter; or the deposit is removed by forcing the effluent back through the effluent openings, through the laminae of the compressed paper pack and thence through the walls of the influent tubular openings and out through the ports. Mr. Fuller stated that the packs, dismantled after use, which he examined, showed a complete absence of stain or other sign of use other than at the edges of the influent openings.

Edge filtration, as distinguished from ordinary filtration through a body of granular material, depends upon the ability to regulate the attenuation of the films in which the liquid passes in streamlike motion. It is essential that the material used in the filter have a rough surface so as to provide passageways. The paper used by the inventor is not only impervious and relatively cheap, but its flexibility allows pressure to be applied to the packs in varying degrees, and thus provides a control of the size of the passageways. This paper is said to withstand ordinary acid solutions up to 10% strength, but filtration is interfered with by alkalis approaching 1%.

Among other accomplishments of this filter it is said to remove the color from swampy water and reduce dilute activated sludge to a 60% water content. As a result of passing certain mixed liquids through the filter several times and increasing the pressure with each filtration, different substances are removed each time, thus accomplishing what for convenience has been designated fractional filtration. English scientists have suggested the possibility of grading bacteria of different sizes, the concentration of enzyme solutions and the separation of ultra microscopic micro-organisms.

Quarrying Stone for LaCrosse County Highways

By F. H. A. Nye

The contour of LaCrosse County, Wisconsin, is one of valleys between ridges, and numerous coulees running up from the valleys between spurs that branch off from the ridges. State highways are laid through the valleys and along the ridges, while county roads lead up into the coulees. Each coulee has a small stream flowing down it into its valley and there joining the larger stream.

Nearly 300 miles of tar-bound macadam has been built in the county and is steadily being added to. The crushed rock required for its construction is obtained from the main ridges at an elevation of approximately 400 feet above the valley, where it is found in large deposits of nearly pure limestone.

LaCrosse County is operating four quarries with a crushing outfit at each, located at points convenient for the highway construction. The quarries are all on lands owned by private parties, who receive 5c per yard for all stone quarried.

The method of bringing limestone from the quarry to the bottom of the valley, where it is crushed and stored in bins for distribution by trucks, is believed to be somewhat unusual. A track is laid from the quarry to the crusher with a diamond turnout at mid-length; on this track run two cars, each having a capacity of about 2,500 pounds. The two cars are connected by a 3/4-inch cable which passes around a drum at the top of the incline. The weight of the loaded car as it descends is more than sufficient to pull back to the quarry the empty car, the two passing each other at the turnout and the speed be-

ing controlled by a brake applied to the drum at the quarry.

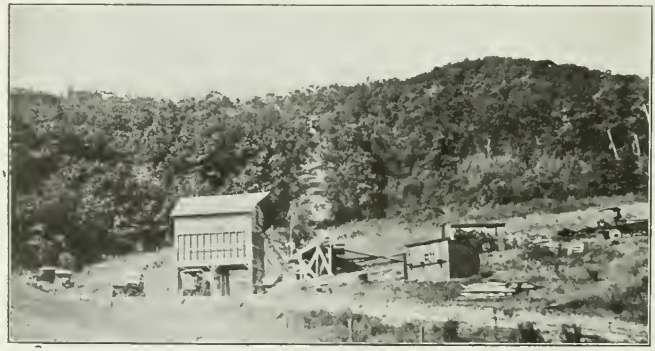
One photograph shows the clearing through the trees from the quarry to the crusher and the other gives a near view of the cars passing each other. The former illustration shows also the crusher, elevator and storage bins. A branch macadamized road leads from the bins to the main highway.

At one of the quarries the machinery is operated by a gasoline engine, but at the others steam engines are used. Water for the engines is obtained from wells. From 15 to 20 men are needed for continuous work in all sections of the plant and receive $3.50 per day of ten hours, at the present time. One hundred yards of crushed stone is considered a good day's work and the cost is figured to be between $1.00 and $1.50 per cubic yard. The stone is divided into three grades by a revolving screen located at the top of the bins.

The track and car equipment was bought at low cost from wrecking companies, the track being obtained as low as $28 per ton. A new crusher cost about $1,400, a twenty-five horsepower steam engine, $1,800, and the gasoline engine, $450. The bin was built of timbers taken from old bridges and cost about $400. The balance of the equipment, including the screen, well and pump, brought the total cost of the steam plant up to nearly $5,000. While the cost of the gasoline engine was much less than that of the steam engine, gasoline costs about the same as coal, and the long usefulness of the steam engine is considered to more than balance its extra cost.

SHEAVE AND BRAKE AT QUARRY FOR CONTROLLING CABLE.

CARS PASSING EACH OTHER MIDWAY BETWEEN QUARRY AND CRUSHER.



STONE-CRUSHER AND TRACK LEADING UP HILL TO QUARRY.

Repairs by Public Service Corporations

The making of repairs to sub-surface structures by the public service corporations has caused so much inconvenience to traffic in New York City that the Bureau of Engineering, with a view to eliminating this condition, has adopted a policy of requiring these corporations to undertake their work during the nighttime. In some cases it has been found necessary to require the work to be continued both day and night throughout the 24 hours. Where it is considered inexpedient to work by day, cuts made during the night operations are planked over so that the thoroughfare may be used to its fullest capacity during the intervening daytime. This policy has proven to be of the greatest help at points of severe traffic congestion.

Maintenance of Granite Pavements

Application of bituminous filler and sand makes a smooth surface and prevents "cobbling."

By R. A. MacGregor,* M. Am. Soc. C. E.

For a number of years the Borough of Manhattan has refilled the joints of granite pavements with a bituminous filler where the original filler has been removed by the action of traffic and the cleaning of the streets.

In some cases the filler has disappeared in a few years, leaving the joints ½ to 1 inch low and thus exposing the corners of the blocks to the blows of traffic. The result is turtle-backed blocks and a rough surface.

In the repouring of the joints the surface is well swept with hand brooms and the joints raked out to remove the dirt as much as possible. Until about three years ago the practice was, after the pavement had dried, to pour the filler into the joints from pots with spouts, but now the practice is to pour the filler from buckets over the surface, spread it with squeegees as thin as possible and then cover the whole with sand. This protects traffic, both vehicular and pedestrian, from the sticky material and vehicular traffic works the sand into the bituminous filler, forming a mastic.

On new work the filler is mixed with hot sand, in the proportion of 40 per cent sand and 60 per cent filler by volume, before pouring and this mixture is then squeegeed into the joints, as little as possible being left on the surface of the blocks.

In either case traffic before long wears the mastic off the surface, while the filler in the joints is rolled flush with the head of the blocks, making a smooth surface and protecting the corners or edges of the blocks from chipping.

The annual reports of the borough show that in 1921 114,400 square yards of granite pavement was so treated at a cost of 38c per square yard, and in 1922 77,400 yards at a cost of 41c per square yard was treated. The costs given might be reduced by the use of machines for mixing, which would be practical for large areas and are being used on large construction jobs.

The use of this method by other city and county authorities might well be considered, both from the point of view of economy in maintenance and of comfort to the traveling public. This was forcibly impressed on the writer on recent passages over one of the causeways between Jersey City and Newark. This is a comparatively new pavement and the blocks are rapidly being worn round or turtle backed. A comparison of this roadway with some in Manhattan 10 to 12 years old would prove the value of maintaining the joint filler flush with the top of the granite blocks.

*Assistant Engineer, Department of Public Works, Borough of Manhattan.

Cost of Test Borings

The commendable practice of obtaining all possible data in connection with underground conditions for the information of prospective bidders is becoming more general but is still comparatively infrequent. Figures concerning the cost of investigating underground conditions are by no means numerous and bids recently received in New York City by the Board of Water Supply for making test borings in the various boroughs of the city and vicinity will undoubtedly be of interest to engineers. Three bids were received as follows:

For making land borings, a total of 11,000 lineal feet, the bids per lineal foot were $4.95, $7.50 and $8, an average of $6.817. For making river borings the bids per lineal foot were $9.95, $17 and $19.25, an average of $15.40. Where the casings were to be left in place the prices bid per pound were 10c, 12c and 30c, an average of 17c. The three contractors were from New York City, Scranton and Pittsburgh, respectively.

Street Inlets and Street Cleaning Statistics

Figures from 154 cities illustrating the relative number that use inlets without catch basins and with catch basins. Also data supplementing tables on street cleaning previously published.

Catch basins are necessary in some locations and under certain conditions, but we believe that fully half of those now in existence are a liability rather than an asset. This idea has slowly been finding acceptance by engineers. To what extent, is indicated by the table on the following page showing conditions in 154 cities in 36 states. As a matter of fact, present practice is more in favor of the omitting of the catch basin than these figures would indicate, since they represent inlets built years ago as well as those constructed in accordance with present ideas. In fact, it seems fair to assume that a city that has any inlets without catch basins realizes that catch basins are necessary only under certain conditions.

Of the cities reporting on this question, almost half (45 per cent.) have built inlets without catch basins, and 24 per cent. have no catch basins in service. These last include some good sized cities, such as Omaha, Neb., Quincy, Ill., and Wichita, Kans. Worcester, Mass., has 550 inlets without basins and 32 with basins.

In the October issue we published tabulated statistics concerning street cleaning from about two hundred cities, and in tables on page 397 we give further information received since those tables were compiled; while on page 396 we

give information from the same cities supplementing the table on "Disposal of Street Sweepings and Garbage" that was published last month. These all remove snow from a part of their streets, except Bonham, Texas, which probably has no snow.

STREET INLETS

City	Number of Street Inlets: With catch-basins	Number of Street Inlets: Without catch-basins
California		
Napa	20	—
Palo Alto	52	—
San Luis Obispo	10	—
San Mateo	4	—
Stockton	223	—
Florida		
Sanford	—	90
Illinois		
Beardstown	30	—
Canton	12	—
Centralia	—	222
Mattson	75	—
Normal	—	5
Quincy	—	7
Indiana		
Elwood	—	48
Fort Wayne	13	—
Gary	25	—
Huntington	30	—
Indianapolis	112	162a
Lafayette	52	18
Peru	41	15
Seymour	—	4
Terra Haute	20	—
Wabash	4	1
Washington	2	—
Iowa		
Clinton	100	—
Mt. Pleasant	12	—
Red Oak	6	—
Kansas		
Emporia	6	17
Manhattan	20	—
Wichita	—	92
Kentucky		
Ashland	10	12
Louisville	240	—
Madisonville	15	—
Louisiana		
Lafayette	—	32
Lake Charles	3	—
Maine		
Augusta	6	—
Portland	30	—
Rockland	1	—
Maryland		
Salisbury	8	—
Massachusetts		
Adams	20	5
Cambridge	23	—
Fitchburg	14	—
Lowell	23	—
Natick	10	—
Newton	82	—
North Adams	16	1
Worcester	32	550
Michigan		
Battle Creek	4	10
Dowagiac	8	—
Hastings	82	—
Ludington	25	—
Marquette	16	—
Mt. Clemens	30	—
Minnesota		
Cloquet	34	—
Faribault	14	—
Hibbing	—	15
New Ulm	34	—
St. Cloud	27	—
Stillwater	96	—
Willmar	36	—
Mississippi		
Clarksdale	—	10
Hattiesburg	—	30
Missouri		
Fulton	—	5
Kansas City	584	—
St. Louis	196	—
Montana		
Billings	3	150
Bozeman	—	29
Great Falls	43	36
Kalispell	4	—
Nebraska		
Lincoln	—	24
Omaha	—	634
New Hampshire		
Concord	20	—
New Jersey		
Bayonne	200	50
Long Branch	20	—
Newark	74	—
New Brunswick	14	—
Phillipsburg	—	20
Westfield	12	—
New Mexico		
Alberquerque	—	350
New York		
Binghamton	41	11
Elmira	41	—
Endicott	12	—
Herkimer	23	6
Ilion	42	3
Johnson City	6	—
Johnstown	13	—
New York—Manhattan	175	—
Ogdensburg	5	3
Oneida	—	12
Schenectady	98	—
Tarrytown	4	—
North Carolina		
Greensboro	35	—
Wilmington	—	24
North Dakota		
Fargo	27	—
Minot	—	125
Ohio		
Alliance	15	15
Ashtabula	40	—
Bowling Green	7	—
Chillicothe	10	—
Circleville	9	—
Dayton	122	36
East Cleveland	25	—
Findlay	245	163
Lakewood	11	39
Logan	6	—
Ohio (continued)		
Marion	6	—
Middletown	—	11
Newark	32	11
Urbana	—	100
Oklahoma		
Ada	20	5
Henryetta	98	—
Muskogee	34	—
Vinita	2	—
Oregon		
Astoria	59	—
Oregon City	20	—
Pennsylvania		
Chambersburg	2	—
Clairton	—	40
Clearfield	—	20
Connellsville	—	1
Dunmore	15	2
Ellwood City	—	12
Luzerne	2	—
Meadville	29	—
Norristown	—	12
Oil City	2	25
Pittsburgh	101	—
Rankin	6	—
Rhode Island		
Pawtucket	24	13
Providence	102	38
South Carolina		
Greenville	40	—
Orangeburg	—	63
Spartanburg	50	—
South Dakota		
Watertown	10	—
Tennessee		
Clarksville	—	10
Dyersburg	30	—
Jackson	—	40
Texas		
Abilene	—	3
Beaumont	—	30
Denison	—	12
Eastland	—	10
Ennis	6	2
Weatherford	10	—
Virginia		
Bristol	40	25
Richmond	233	—
Washington		
Port Angeles	51	—
Spokane	100	—
Tacoma	35	—
Walla-Walla	5	25
West Virginia		
Bluefield	168	15
Fairmont	20	—
Morgantown	—	40
Wisconsin		
Madison	27	52
Oshkosh	—	86
Two Rivers	—	30
Wausau	41	—

a Connected to catch-basins.

DISPOSAL OF STREET SWEEPINGS AND GARBAGE

City	Disposal of Street Sweepings	Change in Disposal of Garbage This Year	New Method Contemplated	Reason for Making Change
Illinois:				
Urbana	Hauled to dump ground	None	.....	.....
Indiana:				
Kokomo	Haul to dump	None—still feed it	.....	.....
Maine:				
South Portland	Carted to dump	None	None	.....
Massachusetts:				
North Adams	City farm	None	None	.....
Minnesota:				
Minneapolis	Taken to dump	.....	.....	.....
New Jersey:				
Millville	Filling lots	None	None	.....
Westfield	Placed in pockets on unoccupied ground	None	None	.....
Ohio:				
Bucyrus	Hauled to city dump	Patrons pay for service	None	.....
Toledo	Hauled to dump	None	Desire some method	Cut expense in half
Rhode Island:				
Providence	Removed by farmers or left on dump	.....	.....	.....
Texas:				
Bonham	Fill in public park	Crematory	.....	.....

STREET CLEANING STATISTICS

City	What percentage of sidewalks does city clean?	Snow Removed by City: From how many miles of streets?	Snow Removed by City: Methods and apparatus used	Area of Streets on Which City Uses: Hand Brooms	Area of Streets on Which City Uses: Machine Brooms
Illinois:					
Urbana	25; snow only	35	Horse-drawn wooden V-shape plows	6 or 7 blocks, business district	None
Indiana:					
Kokomo	None	25	Plow and trucks	35 miles	None
Maine:					
South Portland	None	70	Shovels and teams	15% of width	85% of width
Massachusetts:					
North Adams	None	3, business dist.	Trucks and scrapers	.....	.....
Minnesota:					
Minneapolis	Snow only; all except business streets	30	Shovel into sleds and wagons and dump into sewers	568,400 sq. yds.	.....
New Jersey:					
Millville	None	1, business dist.	Snow plows, cart with teams	53,000 sq. yds.	None
Westfield	5; snow only	1½	Motor truck, snow plow, horse-drawn wagons	30,000 sq. ft. business section	Residential section
Ohio:					
Bucyrus	None	32	1-man grader	20 squares	.....
Toledo	None	4, business sect.	Trucks and wagons	Approx. 10 miles	.....
Rhode Island:					
Providence	None	11	Snow shovels, scoops, road machines, snow removers, plows, trucks	360,000 sq. yds.	628,660 sq. yds.
Texas:					
Bonham	None	None	.....	None	1 mile

City	Area of Streets on Which City Uses: Pick-up Sweepers	Flushing Machines	Hand Flushing by Hose	Day or Night Cleaning by: Machine Sweeping in Business Dist.	Flushing	Average Area Per Man Covered by White Wing or Patrol
Illinois:						
Urbana	None	None	None	Day and occasionally at night	.....	6 or 7 blocks in bus. dist. by patrol
Indiana:						
Kokomo	None	35 miles	None	.....	Night	.....
Maine:						
South Portland	None	None	None	Mostly day	None	None
Massachusetts:						
North Adams	.....	5 mi. paved sts.	.....	Day	Day	.....
Minnesota:						
Minneapolis	1,041,600 yds.	3,393,500 yds.	None	Both	Both	About 12,000 sq.yd.
New Jersey:						
Millville	None	None	1 mi. business dist. gutters	No	Night once a week	.....
Westfield	None	None	None	Day	.....	None
Ohio:						
Bucyrus	None	None	None	Night	.....	10 squares
Toledo	None	All paved sts.	None	Night	Night	App. 8 city blocks
Rhode Island:						
Providence	630,925 sq. yds.	None	None	Night	.....	15,000 sq. yds.
Texas:						
Bonham	.....	None	.....	Night	.....	.....

City	Expenditure Last Year	Notes on Expenditure
Illinois:		
Urbana	$6,086.00	Grading, cleaning, etc.—brooms and shovels 3 or 4 times a year on residential streets.
Indiana:		
Kokomo	18,000.00	.....
Massachusetts:		
North Adams.	6,000.00	.....
Minnesota:		
Minneapolis	602,000.00	For cleaning paved streets and keeping dirt streets repaired.
New Jersey:		
Millville	2,500.00	.....
Westfield	3,500.00	.....
Ohio:		
Bucyrus	4,000.00	.....
Toledo	259,721.00	.....
Rhode Island:		
Providence	140,215.00	.....

Water Supplies of Large Cities

The committee on Municipal Health Department Practice of the American Public Health Association, in co-operation with the U. S. Public Health Service and utilizing funds provided by the Metropolitan Life Insurance Company, has completed a survey of the practice of municipal health departments in 83 cities of the United States of 100,000 poulation or over. This report, made public a few weeks ago, contains 468 pages of very interesting data concerning the health department practice of these cities, and a number of discussions of various features of health department work based upon the results of the survey. Engineers will be especially interested in the chapters relating to water supply, sewerage and sewage disposal.

From a study of the subjects last mentioned it is learned that of these 83 larger cities, 69 own their own water supplies and 3 are supplied by the Metropolitan Board of Boston, leaving only 11 in which the water is supplied by private companies. It was learned that in 29 cities the public water supply is used by 100% of the population and in an additional 26 cities by 95% or more. In the remaining cities the percentage of population using public water supply is less than this, being between 70% and 80% in 5 of the cities, while in Kansas City, Kansas, it is only 68%.

The percentage of population served by the sewerage systems of these cities is considerably less than that served by the waterworks. Estimates of any value were available for only 71 of the cities, and of these 71 only about 84% of the total population is served by public sewers, although between 95 and 100% was served in 27 of the cities. The lowest percentages recorded were as follows: Reading, Pa., 40%; Spokane, 50%; Houston and Des Moines, 55%; San Antonio, 62%; Kansas City, Kan., 63%, and Indianapolis, 65%.

Of all the cities only 10, containing 7.5% of the population of the group investigated, have treatment plants designed to care for the sewage of the entire city. Sixty-one of the cities dispose of their sewage by simple dilution into the nearest body of water, these cities containing a population of over 23,000,000. Five other cities, serving 5.2% of the total population considered, merely pass the sewage through coarse screens.

Sewerage Statistics

Figures relative to amounts and kinds of sewers laid during 1922 in thirty-eight cities, supplementing similar data previously published.

The tabulated data on this page and the following one supplement similar tables published in the July issue. They were compiled from questionnaires received since the preparation of the tables that appeared in that issue. The entire absence of figures for brick sewers serves to emphasize the extent to which concrete is replacing brick for large sewers.

VITRIFIED CLAY PIPE LAID IN 1922

City	Less than 24"—Feet	24" to 36" Feet	Standard or Double Strength
California:			
Visalia	2,200 storm 1,300 sanitary	None	.....
Connecticut:			
Norwich	4,902	....	Standard
Illinois:			
Centralia	3,000	2,200	Both
Chicago H'ghts	3,000	....	.....
Danville	20,000	....	Standard
Glencoe	10,000	600	Standard
Highland Park	3,500	....	Standard
Kenilworth	4,000	1,000	Standard
Winnetka	4,500	....	Standard
Indiana:			
Brazil	7,200	....	Standard
East Chicago	7,934	....	Standard
Elkhart	8,500	2,000	.....
Mt. Vernon	6,000	2,400	Standard
Kansas:			
Salina	14,000	None	Double strength
Massachusetts:			
Haverhill	711	302	.....
Worcester	15,393	8,303	8"-18" std.; 20"-24" double str'gth
Minnesota:			
Fairmont	1,900	....	.....
Mississippi:			
Vicksburg	½ mi.	....	Standard
Missouri:			
Trenton	5,397	980	Standard
New York:			
Buffalo	56,622	None	Double, encased in 1:12 conc. up to springing line
Gloversville	3,200	....	Standard
Ithaca	1,500	....	Double strength
North Carolina:			
Durham	46,907	....	Double strength, 15" and larger
North Dakota:			
Grand Forks	3,708	....	Standard
Oklahoma:			
Chickasha	7,000	....	.....
Enid	14,912	428	.....
Shawnee	15,000	....	Standard
Pennsylvania:			
Tyrone	1,200	600	Standard
Texas:			
Brownwood	120,000	....	Standard
Virginia:			
Lynchburg	12,811	....	Standard No. 1
Washington:			
Seattle	96,214	818	Double, for 12" and larger
Wisconsin:			
La Crosse	9,000	....	Double
Wisconsin Rapids	6,700	300	Standard No. 1
Wyoming:			
Sheridan	5,511	....	Double

PIPE SEWERS OTHER THAN VITRIFIED CLAY LAID IN 1922.

City	Cement-Concrete Pipe: Less than 24" Feet	24" to 36" Feet	Larger than 6" Feet	Other Kinds of Pipe: Kind	Length Feet	Size
California:						
Long Beach	14.6 mi.	6 mi.	....	.....	....	.....
Montana:						
Butte	1,533	377	....	.....	....	.....
New York:						
Buffalo	....	....	....	Conc. Seg. Blk.	815	30"
Gloversville	3,144	....	....	.....	....	.....
North Carolina:						
Durham	3,046	1,258	....	C. I. pipe	9,876	6"
Washington:						
Bellingham	14,796	....	....	.....	....	.....
Seattle	1,299	328	332	C. I. pipe	893	Less than 24"
Wisconsin:						
Puyallup	450	....	....	Cem. drain tile	3,100	8", 10 & 12"

SEWERS OTHER THAN PIPE LAID IN 1922

City	Brick: Length	Brick: Dimensions	Concrete: Length Feet	Concrete: Dimensions	Concrete: Reinforced	Vitrified Clay Segment Block: Length Feet	Vitrified Clay Segment Block: Dimensions
California:							
Long Beach	....	.....	14.6 mi.	.....	.6 mi.	....	.....
Indiana:							
Mt. Vernon	....	.....	300	84 inch	Yes	....	.....
Massachusetts:							
Worcester	....	.....	1,394	54"x84" & 72"	1,084 ft. round	....	.....
Montana:							
Butte	....	.....	252	7' 4"x4' 6"	....	....	.....
New York:							
Buffalo	....	.....	....	.....	....	815	30"
Wisconsin:							
La Crosse	....	.....	1,100	.....	....	.....	....

LABOR-SAVING DEVICES

City	Devices Used by City or Contractor in Constructing Sewers—Kind	Length of Trench Used On—Feet	Devices Used for Cleaning Sewers—Kind	Amount of Work Done—Feet
Connecticut:				
Norwich	.....	.....	Hydraulic rotary cleaner	1,000
Illinois:				
Centralia	P. & H. backfiller	.....	Turbine	.....
Chicago Heights	Trench excavating machine	.....	None	.....
Danville	.....	.....	Turbine	.....
Indiana:				
Brazil	.....	.....	Self-propelling cent. nozzle on fire hose	.....
East Chicago	.....	.....	Kuhlman sewer cleaner	35,000
Elkhart	Clamshell excavator	7,000	Kuhlman sewer cleaner	2,000
Kansas:				
Salina	Trench excavating machine	15,000	Sewer cleaning rods	.....
Massachusetts:				
Worcester	Erie steam shovel, Byers auto crane	.....	Scrapers, horses, hoisting engines	.....
Missouri:				
Trenton	Greiman trenching machine	1,500	.....	.....
Montana:				
Butte	.....	.....	Self-propelling nozzle	.....
New York:				
Buffalo	2 Austin, 2 Parsons trench machines and backfillers	.....	Thompson's patent	Approx. 5 mi.
North Carolina:				
Durham	Parsons trencher	1 mi.	.....	.....
Oklahoma:				
Enid	Austin	6,000	None	.....
Shawnee	Ditcher	.....	Rotary water motors	1,000
South Dakota:				
Huron	Austin	7,000	.....	.....
Texas:				
Brownwood	Austin ditcher	.....	None	.....
Wisconsin:				
Wisconsin Rapids	.....	.....	Turbine sewer machine	1,500

Pollution of the Kansas River

The Kansas State Board of Health has published a report giving the results of a study of the pollution of the Kansas river and its tributaries, made with a view of determining the fitness of the river to serve as a source of municipal water supplies. Samples were collected at selected points at two-week intervals throughout a period of approximately a year and bacteriological and chemical analyses made of them.

From the information thus and otherwise obtained it was concluded that in most instances, above sources of pollution there are a few B. coli due to surface wash and natural soil conditions. This minimum number of B. coli is high as compared with similar conditions in other parts of the country. This minimum should be used as a standard of purity that could reasonably be expected throughout the course of the stream if it received no municipal sewage and storm water.

It is impossible to eliminate municipal storm water pollution, but it is possible to treat sewage so as to eliminate a large percentage of the polluting materials. Sewage treatment should be required where the distance and time between the place of pollution and the source of water supply are too short to permit of sufficient purification to render the water in a reasonably good condition. Treatment should also be required where local nuisance is caused by the inadequate amount of water in the stream receiving the sewage.

It was found that purification takes place to such an extent above the city of Topeka that the water at that city is in a reasonably good condition as compared with most points in the river above sources of pollution; but below Topeka the water does not attain a reasonably good condition before reaching Lawrence, and there is no sufficient flow below Salina to properly dilute the sewage of that city and a local nuisance exists. While conditions below Junction City and Manhattan are at present satisfactory, they may not continue so in the future.

Water Purification Statistics

Of the cities treating water, more than half use sedimentation and filtration and all but five chlorinate.

Of the several hundred cities concerning which waterworks information was collected by us through a questionnaire last Spring, 273 reported that their water supplies were purified in some way. Statistics concerning these were published in our May issue. Since then we have received similar information from seventy additional cities which purify their water, which information has been tabulated in the tables on the two pages following.

Of these cities, 56% use sedimentation basins. Fifty-six per cent. report filtration, 46% by means of rapid sand filtration, 3% by pressure filters and 7% by slow sand filters. Chlorination is used by 93% of the cities, one of them by the use of hypochlorite. Seven per cent. use copper sulphate, 6% employ aeration, and 14% soften the water. Of the sixty-five cities that employ chlorination, 28 do not treat the water in any other way, except that one employs sedimentation when the water is unusually turbid, one employs aeration, and three use copper sulphate.

WATER PURIFICATION

City	Waterworks Municipal or Private	Is Sedimentation Basin Used?	What Kind of Filters?	Is Water Chlorinated?	Is Water Softened?	Is It Treated in Any Other Way?	Cost of Purification Plant	Gallons Treated Last Year	Cost of Labor at Plant	Cost of Chemicals	Cost of Repairs	Cost of Power	Other Cost of Purification
Alabama:													
Florence	..	Yes	Gravity	Yes	Yes	No	.....	.....	.....	.....	.....	.....	.....
Arkansas:													
Eureka Springs	M	Yes	Pittsburgh gravity	Yes	No	.....	$25,000.00	15,000,000	$700.00	$150.00	.....	.....	.....
California:													
El Centro	..	Yes	Sand	Yes	No	No	36,000.00	900,000,000	.....	.....	.....	Ap. $9,000	.....
Redding	P	Yes	None	Yes	No	No	398.33	686,603,902	30.33	367.50	$85.21	None	.....
San Francisco	..	No	Rapid sand	Yes	No	No	4,398.45	39,311,600[a]	926.10	1,112.33	29.10	None	None
San Jose	P	No	Sand and gravel	Yes	No	No	15,000.00	1,500,000	1,020.15	418.30	284.19	$105.00	$36.79
Santa Cruz	M	No	None	Yes	No	No	2,000.00	300,000,000	100.00	.....	.....	.....	.....
Colorado:													
Delta	M	Yes	Gravity	No	No	No	.....	.....	.....	.....	4,000.00	.....	.....
Georgia:													
Atlanta	M	Yes	N.Y. Jewell & Hyatt	Yes	No	.....	.....	.....	.....	.....	.....	.....	.....
Cedartown	M	No	.....	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Newman	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Idaho:													
Boise	P	No	Natural gravel	Yes	No	No	5,000.00	1,000,000,000	None	250.00	150.00	None	None
Weiser	M	No	.....	Yes	No	No	1,500.00	100,000,000	.....	40.00	None	None	None
Illinois:													
Cairo	P	Yes	N. Y. Continental-Jewell rapid sand	Yes	No	.....	60,000.00	1,095,000	2,618.00	6,685.00	1,052.00	.....	.....
Hinsdale	M	...	Sand	No	Yes	No	25,000.00	189,649,743	1,200.00	9,700.00	1,500.00	1,850.00	.....
Rock Island	M	Yes	Mechanical gravity	Yes	No	.....	100,000.00	1,000,000,000	7,200.00	5,500.00	.....	.....	.....
Indiana:													
Bedford	M	Yes	Nons	Yes	No	.....	18,000.00	.....	.....	.....	.....	.....	.....
Goshen	M	Yes	None	No	No	No	20,000.00	400,000,000	5.60	None	None	None	None
New Albany	P	Yes	N. Y. Continental-Jewell rapid sand	Yes	No	.....	75,000.00	724,495,000	2,940.44	1,952.79	53.52	.....	88.84
Whiting	M	Yes	Gravity rapid sand	Yes	No	Aeration	Ap. 200,000.00	1,123,080,000	12,720.00	6,808.43	679.05	13,300.04	.....
Iowa:													
Boone	M	No	None	Yes	No	No	.....	400,000,000	.....	100.00	200.00	.....	.....
Kentucky:													
Cynthia	..	Yes	2 Pittsburgh	Yes	..	.....	35,000.00	500,000 per day	1,855.57	750.00	369.11	6,483.56	.....
Danville	M	Yes	Rapid sand	Yes	No	.....	Ap. 20,000.00	348,000,000	.....	1,186.00	156.59	.....	.....
Maysville	P	Yes	None	Yes	Yes	Yes	1,800.00	365,000,000	365.00	900.00	75.00	None	None
Maryland:													
Baltimore	M	Yes	Mechanical	Yes	No	Lims	1,500,000.00	34,500,000,000	.....	84,467	232.25	97,232.25	67,533.19
Massachusetts:													
Lawrence	M	No	Slow sand	Yes	No	No	$1,240.00	1,660,000,000	.....	35.00	.....	.....	.....
Michigan:													
St. Clair	M	No	Nons	Yes	No	No	1,306.00	273,750,000	.....	64.00	25.00	6,600.00	None
Missouri:													
Liberty	M	Yes	Rapid sand	Yes	Yes	Aeration	20,000.00	.....	.....	2c per 1,000	.....	8½c per 1,000	4c per 1,000, labor
Montana:													
Billings	M	Yes	Rapid sand	Yes	No	No	106,000.00[b]	808,395,200	2,961.25	4,090.39	784.31	48.00	.....
Nebraska:													
Lincoln	M	No	None	Yes	No	No	Ap. 1,500.00	1,972,000,000	Ap. $1,200	Ap. $200	None	.....	.....
New Hampshire:													
Dover	M	Yes	Slow sand	Yes	No	No	.....	.....	.....	.....	.....	.....	.....

WATER PURIFICATION

New Jersey:													
Dover	M	No	None	Yes	No	No	800.00	25,279,200	25.50	40.00	3.40	None	None
New York:													
Avon	M	No	None	Yes	No	Soreen	1,500.00	40,000,000	100.00	39.00	None	None	.....
Binghamton	M	Yes	Rapid sand	Yes	No	Rarely feed lime water	.....	2.5 billion	4,800.00	8,500.00	250.00	.....	None
New York	M	No	None	Yes	No	Copper sulphate	.....	250,000,000	.....	62,000.00	.....	.....	.....
Ossining	M	No	None	Yes	No	Copper sulphate	.....	.....	.....	.....	.....	.....	.....
Watertown	M	Yes	Slow sand	Yes	Yes	No	.....	1,616,454,000	.....	.....	.....	.....	.....
Waverly	M	No	None	No	No	Copper sulphate	.....	.....	.....	.....	.....	.....	.....
Yonkers	M	No	Slow sand	Yes	No	No	796,625.59	3,095,673,200	44,733.76	887.58	.....	84,470.25	.....
North Dakota:													
Wahpeton	M	Yes	Sand	Yes	No	No	24,000.00	132	5,600.00	1,200.00	100.00	.....	.....
Ohio:													
Akron	M	Yes	N. Y. Continental Jewell rapid sand	Yes	No	.....	1,400,000.00	6,000,000,000	20,000.00	27,000.00	500.00	1,800.00	.....
Bowling Green	P	No	None	Yes	No	No	.....	.....	.....	23.00	12.00	None	None
Cleveland	M	No	36 rapid sand	Yes	No	No	2,250,000.00	34,120,000,000	68,004.40	52,595.51	.....	?	None
Columbus	M	Yes	Mechanical	Yes	Yes	No	890,000.00	8,030,000,000	51,800.00	170,000.00	7,200.00	.....	12,300.00
Dayton	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Defiance	M	Yes	Rapid sand	Yes	Lime only	Carbonate of lime	270,000.00	215,165,750	.....	.....	.....	.....	.....
Dennison	P	Yes	Mechanical	Yes	No	.....	Ap. 50,000.00	824,000,000	1,312.19	2,811.84	885.71	21,213.12	228.89
Eaton	M	Yes	Rapid sand	Yes	No	No	30,000.00	4,900,000	.....	450.00	150.00	.....	.....
Oberlin	M	Yes	Excelsior strainers	Yes	Yes	No	.....	110,000,000	360.00	2,795.00	252.64	100.00	.....
Wadsworth	M	Yes	Gravity sand	No	No	No	70,000.00	.....	.....	.....	128.72	.....	.....
Oklahoma:													
Cushing	M	Yes	None	Hypocho. of lime	Only during turbidity	Lime and iron sulphate	30,000.00	70,000,000	.....	1,200.00	50.00	85.00	.....
Hominy	M	Yes	Sand	Yes	No	.....	1,700.00	60,000,000	2,400.00	468.00	424.00	2,352.00	.....
									300.00	308.50	75.00	None	.....
Oregon:													
Ashland	..	No	None	Yes	No	No							
Eugene	M	Yes	Rapid sand	Yes	No	No	$23,000.00	456,000,000	5,800.00	850.00	None	1,300.00	None
Marshfield and North Bend	P	..	.....	Yes	..	.....	.....	900,000 per day	.....	.....	.....	.....	.....
Pennsylvania:													
Chester	P	Yes	Gravity rapid sand	Yes	No	Aeration	216,000.00	2,448,000,000	7,770.00	6,600.00	720.00	None	670.00
Coatesville	M	No	Slow sand and pressure	Yes	No	.....	.....	18,000,000.00	5,508.00	270.00	500.00	3,185.00	2,909.00[c]
Corry	..	No	None	Yes	No	Copper sulphate	7,000.00	300,000,000	.....	37.50	200.00	None	.....
Freeland	P	No	None	Yes	No	No	None	.....	Elec. power	.....	.....	.....	.....
Pittsburgh	M	Yes	56 acres slow sand filters	Yes	No	No	6,990,751.13	37,789 750,000	147,074.52	2,618.31	780.04	.....	11,063.38[f]
Uniontown	P	No	None	Yes	No	No	.....	356,639,040	.....	107.11	2.95	None	360.00[d]
Tennessee:													
Greenville	M	No	None	Yes	No	No	.....	.....	.....	40.00	None	None	None
Texas:													
Corpus Christi	M	Yes	Pittsburgh	Yes	Partly	Alum and lime	Ap. 200,000.00	300,000,000	.....	.....	.....	.....	.....
Dallas	M	Yes	Sand and coal	Yes	Yes	Alum and lime	385,000.00	ap. 14,000,000,000	.....	.....	.....	1,000.00	.....
Lockhart	P	No	None	Yes	No	No	None	45,000,000	None	75.00	25.00	.....	50.00
Washington:													
Bellingham	M&P	..	None	Yes	No	No	1,719.92	6,000,000 daily	.....	1,000.00	12.05	1,800.00	240.00[e]
Seattle	..	No	None	Yes	No	No	.....	60,000,000 daily	None	6,500.00	.....	.....	.....
Walla Walla	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Wisconsin:													
Appleton	M	Yes	Rapid sand	Yes	No	Aeration and copper sulphate	645,313.87	523,940,000	5,600.00	1,996.83	852.92	2,072.11	.....

[a]—Amount filtered; 98,000,000 gallons chlorinated. [b]—Cost in 1915. [c]—High-pressure booster pump power. [d]—For chemical analyses. [e]—Bacteriological examination monthly at $20. [f]—Total cost, $161,536.

Recent Legal Decisions

CONCLUSIVENESS OF ENGINEER'S ESTIMATE OF EARTH EXCAVATED

The Kansas Supreme Court holds, Wilson v. Drainage Dist. No. 2, 213 Pac. 635, that the following language in a contract for the construction of a ditch did not make the engineer's estimates of the amount of earth excavated conclusive: "The engineer shall in all cases determine the quantities of the several kinds of work to be paid for under this contract, and he shall decide all questions as to lines, levels, etc. Any doubt as to the plans and specifications will be explained by the engineer, and his interpretations shall be final and binding upon the parties hereto."

DEPOSIT ON BID FOR STATE HIGHWAY CONSTRUCTION IN EXCESS OF STATUTORY AMOUNT

Contractors bidding for state highway construction work deposited a larger sum than that required by the Washington statute, Rem. Comp. Stat. §6767, which provides for a deposit equal to 5 per cent. of the bid, to be forfeited if the successful bidder fails to enter into a contract and furnish a bond. They afterwards sought to be relieved from their bid on the ground of mistake, and to recover the deposit. The Washington Supreme Court holds, Harrington v. Davis, 213 Pac. 449, that the burden of proof of the mistake was on the contractors, but that a judgment forfeiting the sum deposited in excess of 5 per cent. of the bid was error.

CONTRACTOR HELD LIABLE FOR DEFECTS IN FLOOR OF PUBLIC BUILDING

Specifications prepared by the state architect for the construction of a public building, and forming part of the construction contract, required that certain cement floors be finished according to the master builder's process, with material and by workmen furnished by a designated company, not the contractor. The specifications further required, in effect, that the finish be one-half of an inch in thickness, to bring the floors up from the concrete slab to the specified floor level. The designated company furnished material and workmen to finish the floors, but the workmen applied merely a "skim," in some places thicker than others, but generally of eggshell thickness only. As a result, the floors were uneven and full of waves, cracked and broke through when tapped or stepped on, and had holes in them. In mandamus for delivery of warrants issued for the work, the Kansas Supreme Court holds, Heman Const. Co. v. Mason, 212 Pac. 1089, that the contractor was responsible for the defects. Delivery of the warrants was withheld until the contractor should remedy these defects, which he never did. It is held that the state was entitled to have the warrants canceled.

HIGHWAY CONTRACTOR SHOULD ADVISE CEMENT COMPANY WITHIN REASONABLE TIME IF CEMENT BELOW STANDARD STRENGTH

Where cement ordered by contractors for use in highway construction was claimed by them to be below the standard of strength, the Michigan Supreme Court holds, People v. Alpha Portland Cement Co., 192 N. W. 787, that it was the duty of the contractors so to advise the cement company within a reasonable time if they desired to escape payment for it. This they did not do, although notified by the state highway commission that a portion of a consignment had failed to meet the test as to tensile strength. Instead, they retained and used this carload the same as the rest without complaint or notice to the cement company for over two years after being advised by the state, and not until sued for its value. It was held they must be deemed to have affirmed its previous acceptance when they O. K.'d the original invoices.

PARTIES DEALING WITH MUNICIPALITY MUST KNOW EXTENT OF OFFICERS' POWERS

Parties dealing with a municipal corporation are bound to know the extent of the powers lawfully confided to the officers with whom they are dealing in behalf of such corporation, and they must guide their conduct accordingly; and an agreement, not authorized by ordinance or charter, between a city council and one who had advanced money to those who wished to get jitney licenses that on the surrender of the licenses the unused portion was to be refunded, was beyond the council's powers and unenforceable against the city. Bittick v. City of El Paso (Texas Civil Appeals), 247 S. W. 892.

SUFFICIENT DESCRIPTION IN PETITION TO ESTABLISH HIGHWAY

The Texas Commission of Appeals holds, in Haverbekken v. Coryell County, 247 S. W. 1086, that while, in jurisdictional matters relating to the location of a highway, the provisions of the statute must be complied with, substantial compliance is all that is required. Technical precision is not required in designating the termination of a proposed road. If the description is such that the termination designated therein can be located with reasonable certainty by persons familiar with the locality, and such that it can be located, if necessary, by a surveyor by applying the description found in the petition to the situation found on the ground, it will be deemed sufficient.

INCH-FOOT CHARGES ON DISTRIBUTION MAINS

The New Jersey Board of Public Utility Commissioners in Commonwealth Water Co. v. City of Summit, October 5, 1922, modified a rule requiring a municipality to pay inch-foot charges on all water main extensions, by a provision that no main of less than 6 inches in diameter should be deemed to be a distribution main unless so ordered by the board.

NEWS OF THE SOCIETIES

CALENDAR

Jan. 9-11—ILLINOIS SOCIETY OF ENGINEERS. Annual meeting, University of Illinois, Urbana-Champaign. Secretary, E. E. R. Tratman, Wheaton, Ill.

Jan. 13-19—AMERICAN ROAD-BUILDERS' ASSOCIATION. The annual convention and National Good Roads Show, Chicago, Ill.

Jan. 16-18—AMERICAN SOCIETY OF CIVIL ENGINEERS. Annual meeting at New York City.

Jan. 17—ASSOCIATED GENERAL CONTRACTORS AND AMERICAN ROAD BUILDERS' ASSOCIATION. Joint meeting in Chicago.

Jan. 21-24—ASSOCIATED GENERAL CONTRACTORS OF AMERICA. Annual meeting, Chicago, Ill.

Jan. 22-23—NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION. Annual meeting, Cincinnati, O. Secretary, Edward E. Duff, Jr., Cleveland, O.

Feb. 25-28—AMERICAN CONCRETE INSTITUTE. Annual convention, Chicago. Secretary, Harvey Whipple, 1807 East Grand Boulevard, Detroit.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS

The annual convention of this society was held in Atlanta on November 12 to 16. A description of it will be found in this issue on pages 381 to 383.

AMERICAN ROAD BUILDERS' ASSOCIATION

The annual convention of this association and the National Good Roads Show will be held in Chicago on January 14 to 18. The program and other details will be found on pages 384 to 386.

OHIO FILTER OPERATORS

The Third Annual Conference of Filter Operators of Ohio was held Nov. 21st to 24th at Columbus. Sixty-three of the 65 purification plants in the state were represented. The officers elected for the coming year were: Chairman, Clarence Bahlman; vice-chairman, W. I. VanArnum; secretary, E. E. Smith.

Interesting facts and valuable information were brought out by the papers and discussions. H. T. Campion, superintendent of the Defiance plant, stated that in that plant filtros plates for applying CO_2 had been replaced by perforated pipes and that sand growth had been prevented by introducing one to ten parts per million of CO_2 in the effluent. C. P. Hoover of Columbus described a carbonator recommended for Newark and Columbus; flue gas being scrubbed to remove CO_2 from it and blown through porous concrete blocks. Almost any steam producing plant at the pumping station or vicinity would furnish twice as much CO_2 as necessary.

F. E. Sheehan, superintendent at Portsmouth, told how he reduced the amount of alum coagulant without reducing efficiency. H. W. Streetor described the progress made by the U. S. Public Health Service in studying the efficiency of water purification processes by means of an experimental filter installed at Cincinnati and a survey of sixteen plants. D. H. Rupp stated that in the East Liverpool filter electrolytic action was found taking place between brass strainers of different composition. Strainers also were found plugged with concrete and oakum. A control valve which failed to operate was found to have been installed backward; all of which necessitated a considerable amount of reconstruction.

A joint session was held with the County District Commissioners of Ohio to discuss the use of iodine for eliminating goitre, and it seemed to be the unanimous opinion that application of iodine to water supplies was much more expensive than individual treatment.

PORTLAND CEMENT ASSOCIATION

The 21st Anual Meeting of the Portland Cement Association was held in New York Nov. 19th to 21st. The first day was devoted to meetings of standing committees on Accident Prevention and Insurance, Advertising and Publicity, Conservation, Technical Problems, and others. The second day was devoted to discussion of problems concerning mill practice, papers being presented by Paul C. VanZandt, chief engineer of the Asano Portland Cement Company, on "The Manufacture of Portland Cement in Japan," and by T. H. Cosford, assistant to general manager of the Marquette Cement Manufacturing Company, on "Modern Cement Storages and Improvements in Methods of Loading and Packing and Bag Handling." On Wednesday there were reports of the several committees and the election of officers. F. W. Kelley of Albany, New York, was elected president, Blaine S. Smith of Chicago first vice-president, L. R. Burch of New York second vice-president, and John W. Boardman of Detroit treasurer.

NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION

The Annual Meeting of this association will be held January 22 and 23 at Cincinnati and preliminary plans have already been made by the secretary. To provide time in a two-day session to thoroughly discuss the problems that are met by the salesmen and field promotion men, superintendents and operating managers, and owners and executive officers, it is planned to have group or sectional meetings during the afternoon of the first day, at which these different groups will meet in sections to discuss their respective problems; each section being presided over by a chairman.

The programs for the other sessions have not yet been completed. However, it is proposed that the morning of the first day be devoted to two or three talks by prominent speakers, with ample time for discussion. The entire convention will then lunch together and the sectional meetings will follow. The annual banquet will be held at 6:30 P. M., which will be, as usual, the feature of the meeting. The business session Wednesday morning, where the activities of the past year will be briefly reviewed and the operating policy and budget for the ensuing year will be considered, will bring the meeting to a close about noon.

ADVISORY BOARD ON HIGHWAY RESEARCH

The Advisory Board on Highway Research of the National Research Council met in Washington, D. C., November 8 and 9, with A. N. Johnson, chairman of the Executive Committee, presiding. Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads, in an address entitled, "Objectives of Highway Research," emphasized the thought that the highway engineer, besides faithfully performing his day-by-day tasks, must also engage in research work if he would advance his profession and himself.

Charles M. Upham, state highway engineer of North Carolina, in a paper entitled, "Research Program of North Carolina Highway Commission," laid emphasis on the need of practical highway research and its translation into road service for the highway user.

The chairman of the Committee on Structural Design of Highways, A. T. Goldbeck, presented his report, a digest of which we will give next month. The Committee on Character and Use of Road Materials, H. S. Mattimore of the Pennsylvania Highway Commission, chairman, reported, as the result of this committee's research, that the strength of Portland cement concrete varies with the amount of actual solid material present in a given volume and with the relative parts of this volume that are cement and aggregate. Also, other conditions being the same, the strength varies with the amount of mixing water, but grading of aggregate has a decided effect upon the amount of water that may be used to yield a workable mixture. There is need for research to develop methods for making more uniform concrete upon a large scale in practice in order to apply the information already available in the design of concrete mixtures.

The Committee on Highway Finance, J. G. McKay of the U. S. Bureau of Public Roads, chairman, considered a

budget system an essential part of a highway program. He discussed the use of credit for raising revenue and stated that real property taxation for highway purposes bears too large a portion of the burden of highway expenditures, a survey of four Wisconsin counties showing it to be from 55% to 70% of the total highway revenue; local units producing 47.5%, county units 41.8% and the state 10.7% of the real property revenue. The highway user is largely responsible for highway improvement and should pay a larger part of the cost in the form of motor vehicle and gasoline taxes.

The Committee on Economic Theory of Highway Improvement, T. R. Agg of Iowa State College, chairman, reported that results of investigations published or in process of publication by that committee included "Truck Performance on Grades," "Rolling Resistance and Related Characteristics of Roadway Surfaces," "Economics of Highway Grades," and "Quartermaster Tractive Resistance of Roads Research."

The Committee on Highway Traffic Analysis, G. E. Hamlin of the Connecticut Highway Commission, chairman, called attention to the fact that a traffic census gives information concerning the traffic at that particular time only and it is necessary to endeavor to predict the probable amount and character of future traffic during the life of the several component parts of the highway. It is, therefore, recommended that traffic census counts be taken at critical periods of the year in several successive years and these data be used for plotting curves for predicting future traffic. An outline was given of traffic survey methods and costs in the State of Connecticut. It was reported that a self-recording traffic counting and weighing device, to be operated at minimum cost, is being developed.

The Committee on Maintenance of Roads, W. H. Root of the Iowa Highway Commission, chairman, reported that corrugations form in all gravel roads when the traffic exceeds 500 or 600 vehicles a day and that their formation is in no way dependent upon the construction or maintenance methods but is caused by the displacement of material due to the thrust of the drive wheels and by the impact of both front and rear wheels after a bounce. Dragging with heavy equipment after a rain is a temporary corrective. The report outlined the use of calcium chloride and refined tar on gravel roads and the maintenance of such roads with a mulch treatment of gravel, which consists of frequent light applications of loose, clean gravel up to ¾-inch size.

The Committee believed that expenditures by state maintenance organizations should be divided into: (1) maintenance of ministration; (2) maintenance proper; (3) additions and betterments, and, (4) parks, camping grounds and roadside beautification. The second item would include expenditures for the increased permanent value of the road to accommodate traffic, such as increasing width, new guardrails, drainage structures, etc., and improving grades, alignment and vision. Maintenance costs should be reduced to a ton-mile unit for comparison between states and between types of road surfaces.

The U. S. Bureau of Standards gave progress reports on "Research on Tires" and "Tests of Braking and Stopping Conditions of Motor Vehicles." Dr. H. M. Westergaard, of the University of Illinois, discussed "Mechanics of Stiff Road Slabs."

W. K. Hatt, director of the Board, reported that highway research has made such progress that at present a well-trained and experienced highway engineer can select a type of highway suitable to the conditions of climate and traffic of a given situation, can specify the materials and design the section with a reasonable certainty that it will withstand the specified conditions of service. Much remains to be done, however, in unlocking the stored-up data in the files of state highway commissions, which are now such active agencies in highway research.

The Executive Committee selected for the ensuing year is: A. N. Johnson, chairman; A. F. Flinn, vice-chairman; W. K. Hatt, director; H. C. Dickinson, T. R. Agg, T. H MacDonald, C. M. Upham and A. J. Brosseau.

PERSONALS

Smith, Arthur L., has been appointed Division Engineer in the Alabama State Highway Department with office at Selma.

Howland, Charles A., formerly with the U. S. Department of Health, has been appointed Staff Engineer of the Bureau of Municipal Research, Washington.

Andrews, Harry S., formerly bridge designer for the Long Island Railroad, has been appointed Commissioner of Public Works of Fulton, New York.

Brown, N. Adelbert, formerly engineer of sewage and garbage disposal plants at Rochester, N. Y., is now with the C. O. Bartlett-Snow Company in charge of garbage and rubbish disposal plants. He is now constructing a plant for the company in Philadelphia.

Hopkins, William R., attorney and engineer, was selected on December 6 as the first city manager of Cleveland, Ohio.

Wasser, Thomas J., was elected president for the coming year of the Highway Association of New Jersey.

Albers, John, has been appointed city manager of Beverly Hills, California.

Ramsay, Malcolm, has been appointed city engineer of Temple, Texas.

Whitman, Ezra B., member of the Public Service Commission of Maryland, will become chairman of the Commission on January 1st, next.

Gray, William J., formerly civil engineer in the U. S. Engineer's Office at Wilmington, Delaware, is now superintendent of waterworks at Springfield, Missouri.

Webb, T. H., recently assistant state highway engineer for Texas, has been appointed county engineer of Callahan County of that state.

INDUSTRIAL NOTES

A JAPANESE ELECTRIC MANUFACTURING COMPANY

Westinghouse and Japanese electrical interests are reported to have formed a Japanese electric manufacturing company to be known as the "Mitsubishi Electric Manufacturing Company" with a capitalization of $7,500,000. This company will manufacture Westinghouse products in Japan. A part of the stock is held by the Westinghouse Company, which will profit by a continuous revenue for service and royalties in lieu of profit on exports, while the Japanese will profit by employment given to native workmen.

ORTON AND STEINBRENNER COMPANY

The Orton and Steinbrenner Company of Chicago has just completed a large addition to its plant at Huntington, Indiana, which will approximately double the company's output of locomotive cranes, buckets and other appliances.

UNITED STATES CAST IRON PIPE AND FOUNDRY COMPANY

This company announces the appointment of Thomas P. Anthony as chief engineer with his office at Burlington, New Jersey. Also that P. T. Laws has been appointed southern district manager of the company with his office at the American Trust & Savings Bank Bldg., Birmingham, Alabama.

SCHUBERT-CHRISTY CONSTRUCTION AND MACHINERY COMPANY

Frank H. Schubert and William G. Christy announce the organization of the above-named company with offices in St. Louis, Missouri, where it will represent leading manufacturers of power plant equipment and render general construction engineering services, specializing in the design and construction of water-cooling equipment for refrigerating and power plants, the designing of special machinery, process development and difficult construction work.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

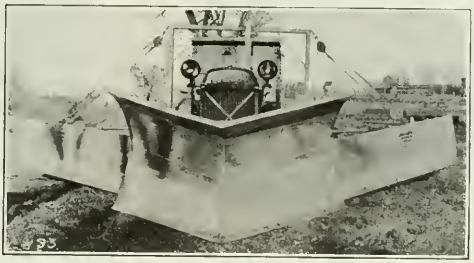
"DRIFT BREAKER" SNOW PLOW

An all-steel V-type plow manufactured by the La Plant-Choate Manufacturing Company of Cedar Rapids, Ia. Points emphasized are strength, mould board shape, ease of operation, and adaptability to conditions. The mould board rolls the snow up and over to the side wings, which are hinged to the main frame and can be extended at any angle to a maximum spread of 28 feet. The wings can be adjusted vertically as well as horizontally, so as to shave off the top of the bank to prevent drifting, if desired.

By means of a hydraulic lift the plow proper can be elevated in seven seconds to give a clearance of at least two feet when traveling over uneven ground, railroad tracks, etc., and when turning around. The pump that operates the jack can exert a pressure of 300 pounds per square inch, controlled from the seat of the driver of the track-laying tractor, for which this plow is especially built.

The main frame is supported by four sled runners. The plow is so attached to the main frame that the two rear points of the sub-frame are higher than the line of power, causing the point of the plow to dig in, but can not go below a fixed point where it is held by oil in the hydraulic jack. It is claimed that the plow, because of the one-unit frame construction, steers much more easily than those having the side wings attached to a trailer.

The ten-ton plow has a height of nose of 54 in., height of rear of V, 65 in., width of plow 10 ft. with wings closed and 28 ft. with them open, and height of wings 36 in. The five-ton plow has dimensions about two-thirds as great.



"DRIFT BREAKER" SNOW PLOW.

BEEMAN SNOW PLOW

A small plow for clearing snow from sidewalks and park walks is produced by the Beeman Tractor Co. of Minneapolis. It is a V plow attached to a Beeman tractor, which in summer is used for operating lawn mowers and other purposes. The point of draft is from the rear of the tractor, thereby preventing the front of the plow from being pushed up. The front of the plow may be raised to clear the curb or other obstruction by pressing down on the handles.

WEHR GRADER FOR SNOW WORK

The Wehr one-man power grader, made by the Wehr Company of Milwaukee, has been used very successfully for handling snow in St. Paul and other cities. Early this year, in that city, one man and a Wehr 9,400 lb. grader cleared snow from 32 miles of streets in two days. A standard Fordson tractor is the power unit, which enables the user to get quick service on any motor part anywhere in the country.

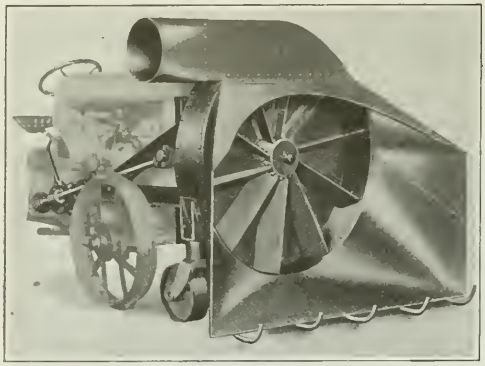
The grader is constructed with a heavy steel channel frame carrying a 6-foot blade, which can be raised or lowered or tilted at any angle desired. The power unit is behind the blade and the weight of it is utilized to hold the grader steady on the road when working. The motor is swung on a three-point suspension so that no unnecessary strains are put upon it.

DALLMANN ROTARY SNOW PLOW

A snow plow for use with a Fordson tractor manufactured by the Dallmann Machine & Mfg. Co., of 921 Winnebago St., Milwaukee. A rotating propeller throws the snow to one side of the road. The plow can be driven in high gear through the average fall of snow, clearing a path wide enough for one-way traffic and clearing the other side of the road on the return trip.

WEHR ONE-MAN GRADER AS A SNOW PLOW.

BEEMAN SNOW PLOW.



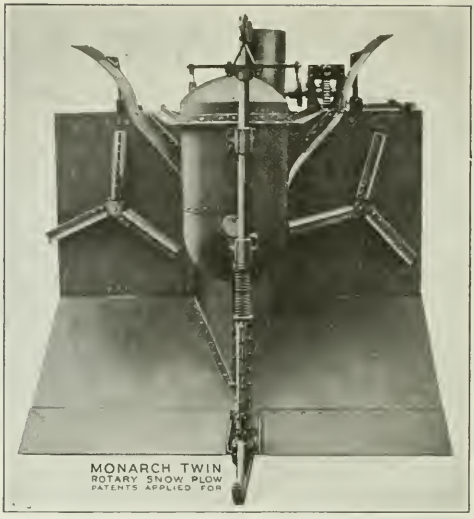
DALLMANN ROTARY SNOW PLOW.

Power is taken from the tractor through a specially designed Smith Unit, which transmits power through a pair of spiral bevel gears, enclosed in a grease-tight housing, through a heavy propeller shaft, a heavy-duty universal joint and forward drive gears. The plow, with its apron and snow propeller, rides on its own wheels, and the entire mechanism is free to rise and fall with the irregularities of the road.

When bucking heavy drifts the driver can shift to low gear. A special starting device, which enables the operator to spin the motor, assures an easy and quick start.

No drilling or tapping is required in attaching the snow plow to the Fordsome. A pivoted anchorage is provided by brackets bolted on either side of the crank case by means of the studs that already connect the two sections of this.

In operation, the tractor pushes the apron into the snow, which is thus guided into the propeller which, rotating at high speed, throws it through the discharge opening to the side of the road. Any tendency to stall in a heavy drift can be prevented by slowing the forward motion or backing up, allowing the propeller to clear itself.



MONARCH TWIN ROTARY SNOW PLOW.

BAKER SNOW PLOW

A plow to be attached to an auto truck, made by the Baker Manufacturing Co. of Springfield, Ill. The outstanding feature is a set of safety tripping blades. This was described in this department of the issue for October, 1923.

W. & K. SNOW AND STREET BRUSH

Arranged to be attached to a Fordson tractor, made by the Whitehead & Kales Co. of Detroit. A rotary brush is driven direct from the tractor motor. This was described in this department of the issue for October, 1923.

MARTIN SNOW REMOVER

An all-steel, reversible, adjustable snow blade made by the Owensboro Ditcher & Grader Co., of Owensboro, Ky. Drawn by two horses, a single blade will clear a sidewalk or gutter. With Model 20 twin blades, each 5 feet long and 17½ inches wide at the cutting end, hauled by a tractor or several teams, heavy snows can be handled, street car tracks kept free of snow, etc.

TWIN MARTIN SNOW REMOVER.

When not in use as a snow remover, the snow blades can be removed and each used separately for street grading. The Martin has no cogs, levers or wheels—nothing to break or get out of order.

MONARCH TWIN ROTARY SNOW PLOW

A rotary plow which throws the snow to either or both sides of the road, manufactured by Monarch Tractors, Inc., of Watertown, Wis. It is a self-contained unit, powered by a Beaver heavy-duty industrial motor. Two heavy steel fans are chain-driven at a speed of about 350 r. p. m. Each fan can be disconnected independently by means of a twin disc clutch. The fans run on heavy Timken bearings and the whole construction is strong and simple. The front shoe and rudder are designed to assist in steering, but the plow can be controlled easily by the tractor through heavy, oscillating push bars attached to the crawlers. Movable vanes around the fan control the height and distance to which snow may be thrown.

The plow is 8 feet wide and weighs about 4,500 pounds. It is intended to take care of snow conditions that can not be handled by the easier methods of straight plowing heretofore used.

FOX ROTARY SNOW SWEEPER

A rotary broom and "turbine" for throwing snow from the roadway, manufactured by the Fox Rotary Snow Broom Company of Newark, N. J. It can be mounted on any standard truck of from 3 to 5 tons capacity. It consists of a broom 34 ins. in diameter with bristles of ¼ in. rattan sweeping a width of nine feet and revolving at 400 r. p. m. (This can be changed to 125 r. p. m. for sweeping street dirt.) When working on highways the snow

FEDERAL

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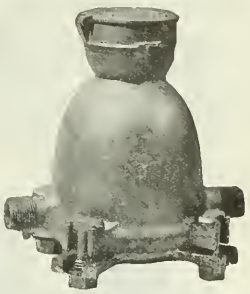
of Sound Design
and Superb Quality



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Ready to deliver, Now.

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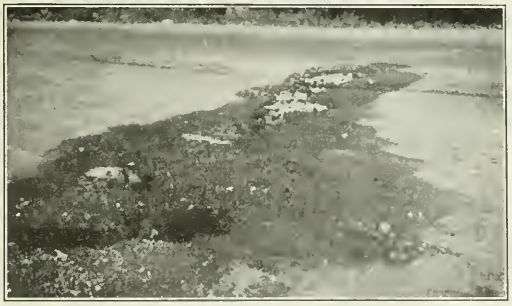

Street Injured by Leaking Main

The penalty for installing inferior pipe for water mains will always be heavy. Aside from the loss of water and the increased cost of pumping due to leakage, officials must consider the probability of torn-up streets and the danger of property damage.

Bell and spigot cast iron pipe properly installed is leak-proof, which is one reason why it has been the standard in water works installations for decades.

United States Cast Iron Pipe & Foundry Co.

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Kansas City: Interstate Bldg.

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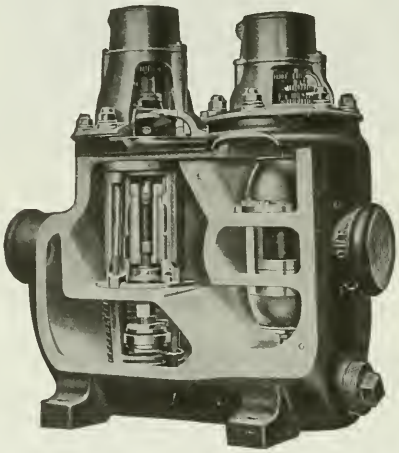
Cincinnati: Dixie Terminal Bldg.

BADGER
WATER METERS



Designed to handle Services where the demand is for large volumes of water

with very little loss of line pressure

BADGER Meters insure accuracy, capacity and low maintenance. Selling water through Badger Meters means a square deal both to the consumer and to the water plant, because they measure ACCURATELY.

The Badger Compound Meter, illustrated here, is an example of the high efficiency of all Badger Meters.

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SAFEGUARD YOUR DOMESTIC WATER SUPPLY

Have a dependable fire fighting unit. Take no chances with purchased power. Discard that standby steam plant and use—

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FIRE ENGINE OF REFINEMENT

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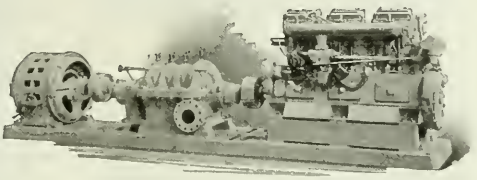
These and many others, in practically every state in the United States and Province in Canada, use STERLINGS.



STERLING six cylinder engine, 180 H.P. at 1200 R.P.M., on Allis-Chalmers 1000 G.P.M. at 246 ft. head Underwriters Fire Pump, Louisville Cement Company, Sellersburg, Indiana.

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Single Units up to 300 H. P., 600 to 1500 R.P.M.

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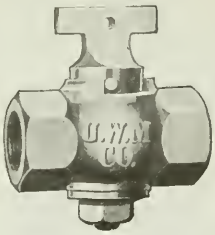

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For nearly fifty years we have been making a stop that we could guarantee against sticking.

All Union corporation, curb and waste stops will turn easily as long as they last. They can not help but do so by the very nature of their construction.

Each plug is solid except for the necessary waterway and is hand ground of the best bronze composition. After being ground into its body a special treatment discovered by Union engineers is applied which will not dry or gum and insures the easy turning feature.

These stops are stronger and heavier than most and we guarantee them to render unusually good service.

Union Water Meter Co.
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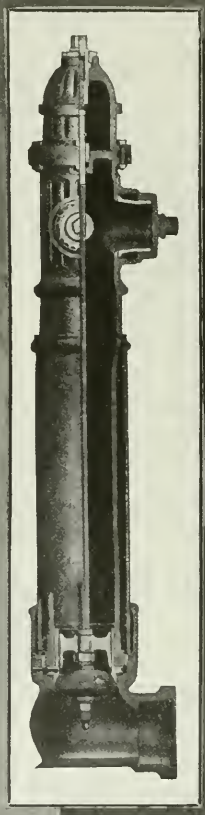
FIRE HYDRANTS



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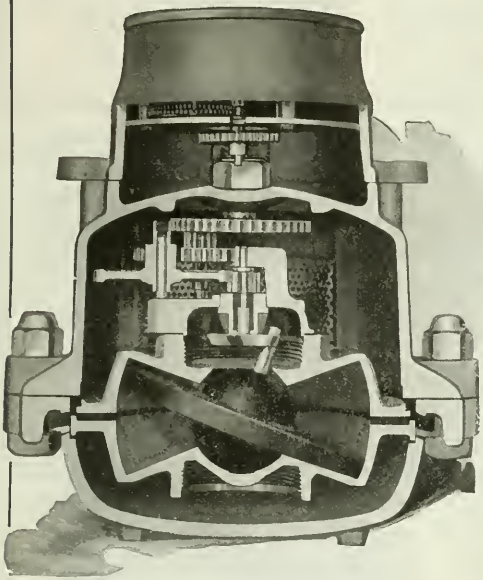
WITH BREAKABLE FROST BOTTOM



The ONLY frost protected meter in which a new seat for the disc chamber is provided after each freezing. The ONLY meter in which the intermediate gearing separates when meter is frozezn. The ONLY breakable frost bottom meter that assembles right side up.

CASING—Bronze with breakable frost bottom.
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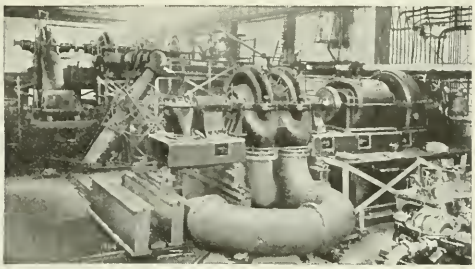

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IT is of the utmost importance that turbine driven pumping units be thoroughly tested in the works of the builder, as a unit, and before shipment. A complete shop test insures fulfillment of the guarantees as to efficiency, capacity and other characteristics and also develops any minor defects in construction, which can be corrected with much less trouble in the shops of the builders than after installation of the apparatus in your plant.

The De Laval test room is equipped for the complete testing of the largest units. The accompanying photograph shows two large geared turbine driven centrifugal pumps set up for test in the De Laval test room. The unit in the foreground is designed to deliver 20,000,000 gal. per day against 450 ft. head, and is to be installed in the new Fairmount pumping station at Cleveland, Ohio. The one at the rear is rated at 30,000,000 gallons per day against 275 ft. head, and is one of the new units recently purchased by the City of Atlanta.

We have also a test room for small and medium sized pumps and turbines, which is equipped with built-in Venturi tubes, gages, test stands, etc. for quick and accurate work.

If you would like to study our methods of testing pumps and turbines or to obtain advice as to testing equipment which you have already installed, we would be glad to show you our testing plant in operation.

Our engineers will also take pleasure in studying your power or pumping problems, and in recommending the most suitable type of equipment to suit your requirements.

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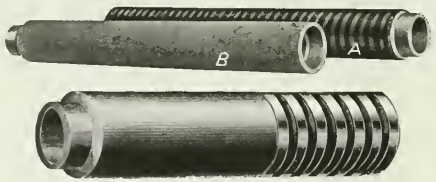

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Will furnish pipe to suit conditions.
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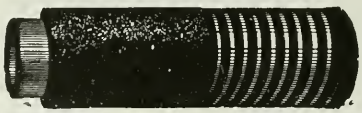

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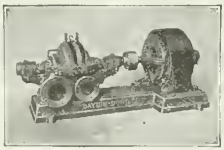

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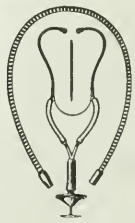
Offices in Principal Cities

PUMPS



TRANSMITOPHONE

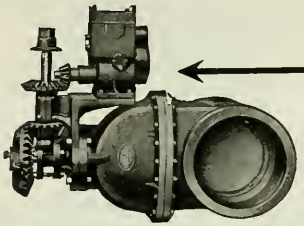
An Instrument recommended by us to the Water Works Man, Sanitary Inspector, Meter Inspector, Repairers of Steam System and Heating Plants, Automobile Manufacturer and Repairers, as well as Engineers for

LOCATING LEAKS IN WATER MAINS, STOPPAGES IN DRAINS, KNOCKS in PUMPING ENGINES or AUTOMOBILE ENGINES.

Being covered by our GUARANTEE is a tribute to its EFFICIENCY.

Water Works Equipment Company

Tel. Cortlandt 0986 50 Church St., New York, N. Y.



DEAN ELECTRIC CONTROL OPERATING 24-INCH WATER GATE. FOR INSTALLATION IN WET STREET VAULT.

ELECTRIC VALVE CONTROL

THE DEAN SYSTEM FOR REMOTE OPERATION OF DISTRIBUTION LINE GATES

PAYNE DEAN LIMITED

STAMFORD, CONN.

PITTSBURG NEW YORK CHICAGO

If You Have a DEEP WELL ending in WATER-BEARING SAND OR GRAVEL.

equip it with the COOK PATENT BRASS TUBE WELL STRAINER and secure the maximum capacity of the well free from sand or particles of any kind. These strainers are in use by the Department of Water Supply of New York City, Parkersburg, W. Va., Memphis, Tenn., and Dayton, Ohio.

Upon the completion of the well, allow me to quote upon a Steam Belt or Motor Driven Deep Well Pumping Outlet.

Write for New Catalogue

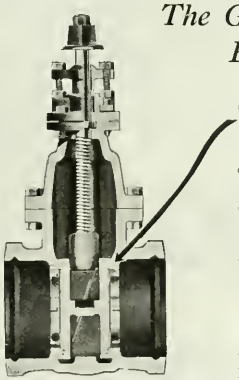
A. D. COOK, Manufacturer Lawrenceburg, Ind., U. S.

When You Write Advertisers You Will Do Them and Us a Favor by Mentioning PUBLIC WORKS

DARLING

A Better Gate Valve

Stays Tight—Easily Operated—Long Wearing



The Ground Faces Free From Injury

The construction of the Darling Gate Valve is such that the Ground Faces are free from injury and undue wear as the Valve is being closed or opened.

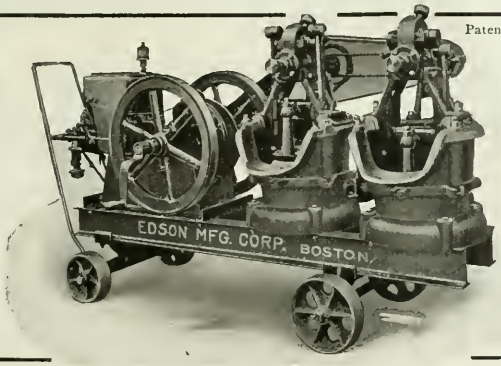
In closing the Valve the Discs descend **free** and **clear** of the Seats until the Lower Wedge reaches the boss in the bottom of the case and the Discs then being in front of the Seats, further downward movement of the Upper Wedge forces the Discs **squarely** against their Seats. In opening the Valve the first turn of the Stem **withdraws** the Upper Wedge from contact with the Lower Wedge, instantly releasing both Discs from their Seats **before** they start to rise.

This is but one of five major features which make Darling Gate Valves so desirable.

Darling Valve & Manufacturing Company

WILLIAMSPORT, PA.

NEW YORK CHICAGO OKLAHOMA CITY HOUSTON



Patents Allowed and Pending

EDSON

Reg. U. S. Pat. Off.

DIAPHRAGM PUMP SPECIALTIES

Hand, Gasolene and Electric Outfits

EMERGENCY One or Two Pump UNITS with 3-inch or 4-inch Suction

For QUALITY specify GENUINE EDSON Pumps, Suction Hose, Diaphragm with Bead, etc.

EDSON MANUFACTURING CORP.

373 Broadway, Boston, Mass.

CAST IRON PIPE
AND FITTINGS

American Cast Iron Pipe Company
Birmingham, Ala.

SALES OFFICES IN PRINCIPAL CITIES

JAMES B. CLOW & SONS
General Offices:
534-546 South Franklin Street, Chicago
Works:
Coshocton, O. Chicago, Ill. Newcomerstown, O.
Sales offices in all principal cities
Manufacturers of Cast Iron Pipe and Fittings

DONALDSON IRON CO.
EMAUS, LEHIGH CO., PA.
MANUFACTURERS OF
CAST IRON PIPE
FOR WATER AND GAS
ALSO SPECIAL CASTINGS AND FLANGE WORK

GLAMORGAN PIPE & FOUNDRY CO.
LYNCHBURG, VA.
GENERAL FOUNDERS AND MACHINISTS
Manufacturers of
CAST IRON PIPE
For Water and Gas, Flange Pipe and Fittings
Western Office: 466 Peoples Gas Bldg., Chicago

LYNCHBURG FOUNDRY COMPANY
Manufacturers of
CAST IRON PIPE AND FITTINGS
Main Offices: LYNCHBURG, VA.
Works at Radford, Va. and Lynchburg, Va.

National Cast Iron Pipe Co.
Birmingham, Ala.
Manufacturers of
Cast Iron Water and Gas Pipe
SALES OFFICES:
Peoples Gas Building, Chicago, Ill.
Kirby Building, Dallas, Texas
Commerce Building, Kansas City, Mo.
Rialto Building, San Francisco, Cal.

$2.50 Per Day *and upward*

is one reason for the rapidly growing popularity of the Hotel Martinique.

Another is the consistent economy of the entire establishment. Here you may enjoy a Club Breakfast at 45c., consisting of Fruit or Cereal, Bacon and Egg, and Rolls and Coffee—Special Luncheon and Dinners of superior quality are also served at the most moderate possible prices.

No location can be possibly more convenient than that of the Martinique. One block from the Pennsylvania Station (via enclosed subwey)—Nine blocks from Grand Central—one block from the greatest and best Shops of the City—half a dozen blocks from the Opera and the leading Theatres—and directly connected with the Subway to any part of the City you wish to reach.

"The BEST without extravagance"
Hotel Martinique
Affiliated with Hotel McAlpin
Broadway-32nd to 33rd Sts.
NEW YORK
A. E. Singleton, *Manager.*

The Book on Construction Equipment

Here is a new book that helps the user of construction equipment to get the most out of every dollar he spends. It contains in convenient alphabetical arrangement, complete cost data on every kind of construction equipment.

HANDBOOK OF CONSTRUCTION EQUIPMENT
Its Cost and Use
By Richard T. Dana
849 pages, flexible, 351 illustrations, $6.00 net, postpaid.

The aim of the book is to assist the contractor and the engineer in the selection and application of the best methods in the least time. It eliminates guess and enables cost estimates to be made on the basis of definite knowledge.

Public Works 243 West 39th St. New York City

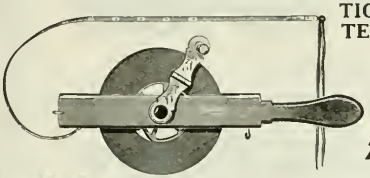
When You Write Advertisers You Will
Do Them and Us a Favor by Mentioning
PUBLIC WORKS

LUFKIN ENGINEERS and CONTRACTORS

TAPES

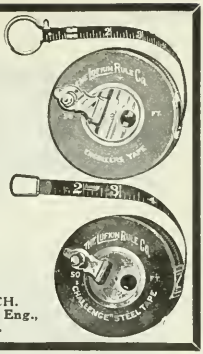
Give Long and Satisfactory Service Even Under Severe Conditions of Use.

FROM SURVEYS TO FINISHED CONSTRUCTION AND INSPECTION WE HAVE PATTERNS BEST SUITED TO EVERY PURPOSE



Stocked by Hardware and Engineering Supply Houses.

Send for Catalogue.



THE LUFKIN RULE CO. SAGINAW, MICH. New York, London, Eng., Windsor, Can.

Clean Water Mains Deliver Full Capacity

If there is growth or deposit in your mains it will seriously affect the carrying capacity. It will cost a great deal less to send water through clean mains.

During the past 15 years we have cleaned mains in several hundred cities and the results in increased pressure and reduced operating costs have been thoroughly satisfactory.

We are glad to confer with municipal officials or water companies.

National Methods Are Patented

National Water Main Cleaning Co.

54 Church St. New York

Liquid Chlorine
38740
Your order for a 100-lb. cylinder of CHLORINE will be executed with the same care and promptness as that of a larger quantity.
By the same token and by reason of our facilities, we are able to dispatch a tank car with that same precision and exactitude.
Electro Bleaching Gas Co.
PIONEER MANUFACTURERS of LIQUID CHLORINE
Main Office: 9 East 41st St., New York
Plant NIAGARA FALLS N.Y.
Chicago Office: 105 W. Monroe St.
EBG

Bourbon Fire Hydrants, Gate Valves

AND

Extension Valve Boxes

WATER WORKS and FIRE DEPARTMENT SUPPLIES

THE BOURBON COPPER AND BRASS WORKS CO.

618-620 E. FRONT ST. CINCINNATI, OHIO

TRADE MARK
Kinney
REG. U.S. PAT. OFF.

Time and Labor Savers

Road Planer

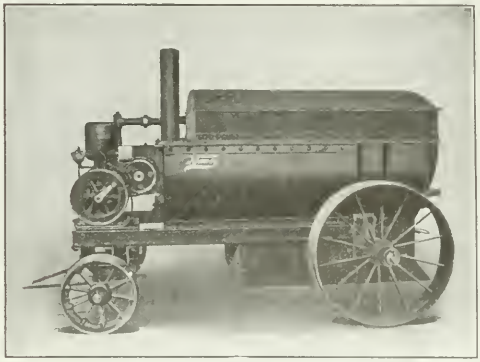
For planing or leveling the waves or ridges that frequently appear on the road surface; without destroying the contour of the surface.

May be used on bituminous roads, macadamized or dirt roads.

Patent Combination Auto Heater and Sprayer

Heats and applies under pressure all varieties of Bituminous materials; hot or cold. Heat and volume under instant control.

The tank and entire equipment can be removed and truck used for other purposes if desired.



Handy Heater and Sprayer

Especially Adapted for Road Maintenance, Construction and General Repair Work

Contents thoroughly agitated while heating. No burning or coking of material. Pump, Piping, Hose, Nozzles, Automatically Heated. No Steam Required.

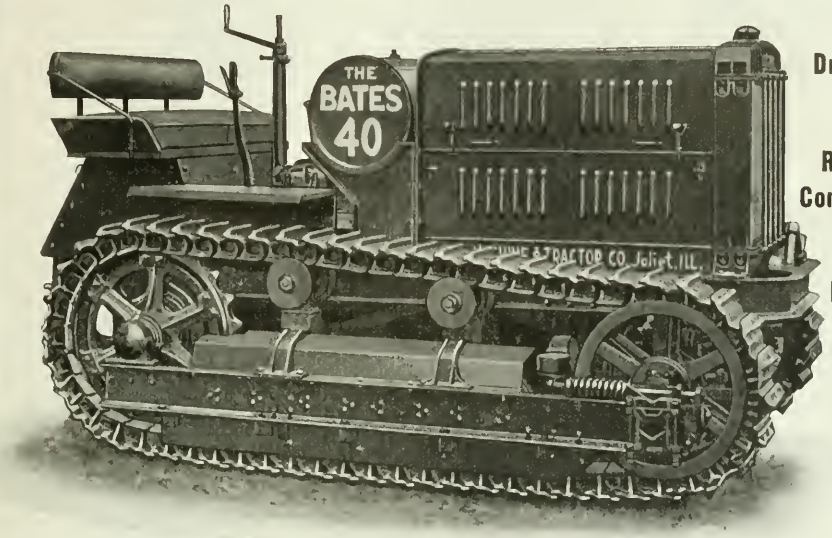
Kinney Manufacturing Company

BOSTON, MASS.

New York *Philadelphia* *Chicago* *Houston* *Kansas City* *San Francisco*
Philippine Islands *Porto Rico* *Cuba* *Hawaiian Islands*

The New Bates "40"

"The Most Efficient Tractor in America"



Big Drawbar Pull

Rugged Construction

Unusual Durability

City of Toledo Prefers BATES Tractors

Stephen A. Foster, Commissioner of Streets, Toledo, Ohio, says: "The BATES Tractor has filled all of our requirements. It is a splendid machine and would want nothing better for all kinds of work. It is perfectly satisfactory and glad we got it."

Road Contractors, Street Commissioners and Highway Officials all through the Country are enthusiastic in their endorsement of BATES Road Tractors. Their merit has been proved by remarkable field service.

An interesting Booklet describing the new 1924 BATES "40" Tractor will be mailed on request. A postal card requesting Booklet "F" will bring it to you without delay

NOTE—We have a few excellent territories open for live Distributors
If there is no BATES Distributor in your territory write us today

Bates Machine and Tractor Co.

Established 1883

JOLIET, ILLINOIS

U. S. A.

STANDARD

COLD PATCH ASPHALT
SOCONY BRAND

For repairing bituminous macadam roads—economically and lastingly.

RUTS and small holes promptly repaired with Standard Cold Patch Asphalt mean lower maintenance costs now and fewer expensive operations later on.

Its permanency, spreading qualities and ease of application save time, labor and material. Workable the year round.

Other Standard Asphalt Products

Standard Asphalt Binder A *for surface treatment.*
Standard Asphalt Binder B *for penetration work.*
Standard Asphalt Binder C *for the mixing method.*

Standard Refined Mexican Asphalt *for sheet asphalt paving.*

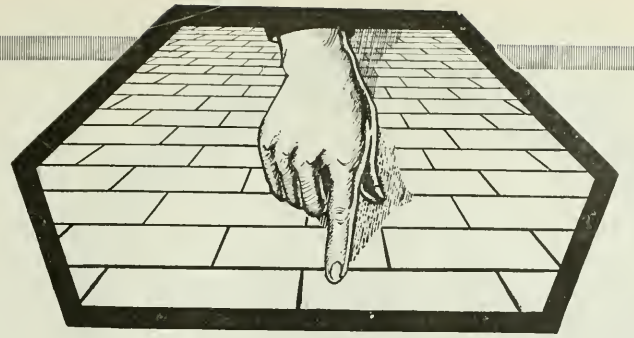
Standard Asphalt Joint Fillers *for brick or block pavements.*

Standard Paving Flux, Standard Bridge Asphalt and Preserving Oils.

Specifications and all other particulars furnished on request.

SOCONY ASPHALTS AND ROAD OILS

STANDARD OIL CO. OF NEW YORK, 26 Broadway



Salvage Value—100%

Albion Shale Brick Company
Albion, Ill.
Alton Brick Company
Alton, Ill.
Barr Clay Company
Streator, Ill.
Binghamton Brick Company
Binghamton, N. Y.
Cleveland Brick & Clay Company
Cleveland, Ohio
Clydesdale Brick & Stone Co.
Pittsburgh, Pa.
Coffeyville Vitrified Brick & Tile Co.
Coffeyville, Kans.
Collinwood Shale Brick Company
Cleveland, Ohio
Corry Brick & Tile Company
Corry, Pa.
Francis Vitric Brick Company
Boynton, Okla.
Georgia Vitrified Brick & Clay Co.
Augusta, Ga.
Globe Brick Company
East Liverpool, Ohio.
Hammond Fire Brick Company
Fairmont W. Va.
Hocking Valley Brick Company
Columbus, Ohio.
Independence Paving Brick Co.
Independence, Kans.
Mack Mfg. Company
Wheeling, W. Va.
C. P. Mayer Brick Company
Bridgeville, Pa.
Medal Paving Brick Company
Cleveland, Ohio.
Metropolis Paving Brick Co.
Pittsburg, Kansas
Metropolitan Paving Brick Co.
Canton, Ohio.
Mineral Wells Paving Brick Co.
Mineral Wells, Texas.
Moberly Paving Brick Company
Moberly, Mo.
Murphysboro Paving Brick Co.
Murphysboro, Ill.
Patton Clay Mfg. Company
Patton, Pa.
Peebles Paving Brick Company
Portsmouth, Ohio
Pittsburgh Paving Brick Company
Pittsburgh, Kansas
Purington Paving Brick Company
Galesburg, Ill.
Southern Clay Mfg. Company
Chattanooga, Tenn.
Springfield Paving Brick Company
Springfield, Ill.
Sterling Brick Company
Olean, N. Y.
Streator Clay Mfg. Company
Streator, Ill.
Thornton Fire Brick Company
Clarksburg, W. Va.
Thurber Brick Company
Ft. Worth, Texas.
Toronto Fire Clay Company
Toronto, Ohio
Trinidad Brick & Tile Company
Trinidad, Colo.
Veedersburg Paver Company
Veedersburg, Ind.
Western Shale Products Company
Fort Scott, Kans.
Westport Paving Brick Company
Baltimore, Md.

VITRIFIED
Brick
PAVEMENTS

WHEN Duval County, Florida, thirteen years ago, paved the Pablo Beach Road with brick, the county engineers proved themselves farsighted care-takers of the public funds.

After the wear and tear of thirteen years had finally battered the surface until it was no longer perfectly smooth, the engineers of 1923 discovered an interesting truth—*that the brick bought in 1910 was worth more in 1923 than the county had originally paid for it.*

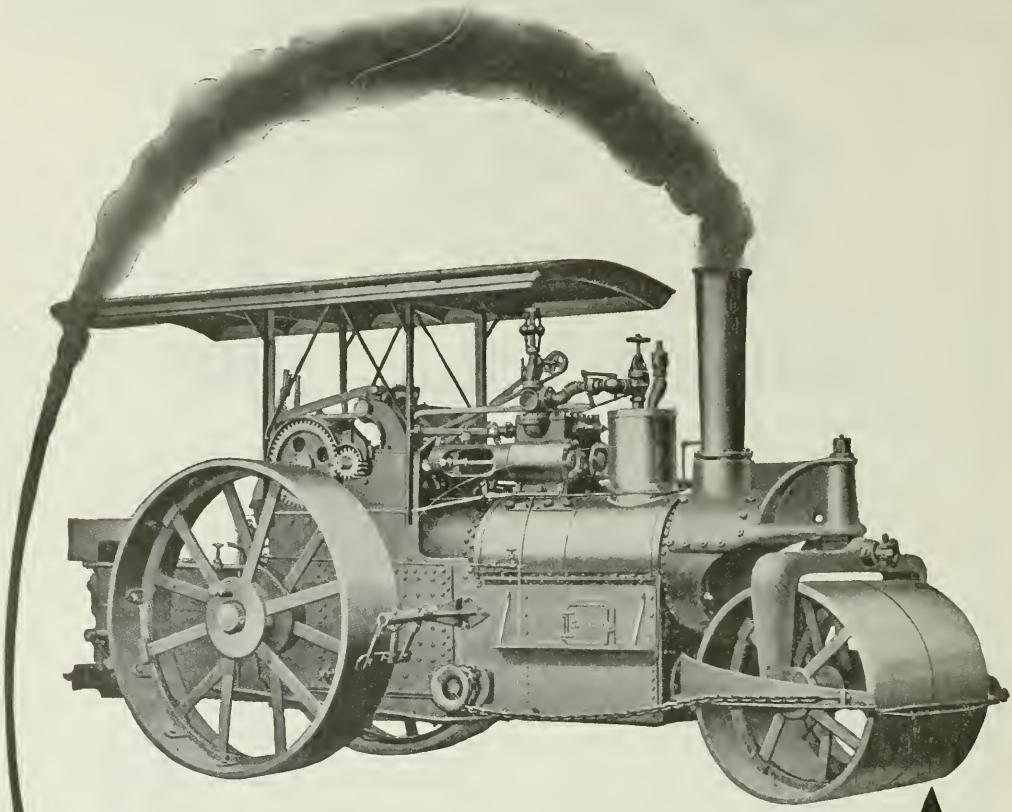
Lifting the bricks out of their places, exposing the base, they found and corrected the cause of the trouble. Regrading and in part rebuilding the base, they relaid the brick of 1910, applied the asphalt filler, and sent the bricks back to another decade or more of service.

A new roadway with virtually no cost for surfacing material—(only a few new brick were purchased).

Have you ever looked at the brick in the pavements in your community from that angle?—do you realize that they have a salvage value that may today be greater than their first cost—and that the brick pavements you lay today will have a similar asset value a generation or more from now?

NATIONAL PAVING BRICK
MANUFACTURERS ASSOCIATION
ENGINEERS BLDG. CLEVELAND, OHIO

OUTLAST THE BONDS



The Allport Construction Co. of Asheville, N. C., are using a Galion Steam Roller equipped with scarifier and this is what they tell us in their letter of June 16th, 1923:

"We were very agreeably surprised recently when we had occasion to scarify a street in the town of Black Mountain, N. C., which had been paved with macadam. This street is on a grade of about twelve to fifteen percent and the macadam had to be removed in order to replace same with concrete. We found that this roller went up this steep grade with the scarifier down to its full depth without a single stop for anything. After having had the experience we had with other well known make of roller, we honestly did not expect the results that we got and felt that we would like for you to know how well it had performed for about a year and a half without any expense for repairs."

Write us for catalogue showing our complete line of Contractors' and Road Builders' Equipment.

THE GALION IRON WORKS & MFG. CO.

GALION, OHIO

Can You Ignore a Saving of Half?

Good management in municipalities expresses itself in improved service at lower cost.

In the handling of ashes, garbage, road materials, etc., Walker Trucks serve municipalities with the same distinction and economy which have made them the choice of hundreds of the leading corporations and business enterprises of America.

Horses and wagons cannot compete with Walkers in economy even on house-to-house work. Gas trucks employed for haulage on city routes usually cost 50% to 100% more than Walkers doing the same work.

Twenty highly organized corporations, including—

American Express Co., U. S. — Bush Terminal Co., New York
Commonwealth Edison Co., Chicago
Marshal Field & Co., Chicago — National Biscuit Co., U. S.,

now operate a total of more than $6,500,000 worth of Walkers — purchased on 265 repeat orders. Such municipalities as New York and Chicago operate increasing fleets of Walkers. Walker users find that 85% of trucking and delivery on city routes is electric truck work — and that the Walker is the leading electric.

Before you buy more trucks, investigate the Walker Electric. Look for the disc wheeled Walkers in your city. Ask their users.

WALKER VEHICLE COMPANY, Chicago

LEADING MANUFACTURER OF ELECTRIC STREET TRUCKS

New York Boston Philadelphia Buffalo
Newark Atlanta New Orleans

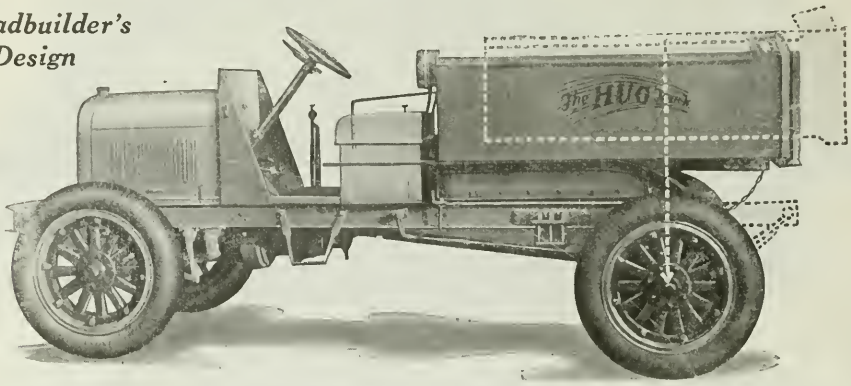
Load Capacities: ½—1—2—3½—5 tons

WALKER ELECTRIC TRUCKS

LOWEST TRUCKING COST ON CITY ROUTES

Still More Speed on the Road Job

A Roadbuilder's Own Design



THE NEW HUG TRUCK

Dotted lines show extension of frame and awkward centre of gravity on customary altered commercial truck. Note superiority of the low-lying, forward-slung, specially designed Hug Gravity Dump Body.

The advantages of power dump bodies have at last been combined with Gravity Dump design in the special Hug Body for the New Hug Truck for 1924!

In addition to the achievement of a new low center of gravity on the New Hug Truck, the weight of the load is also thrown well forward of the rear axle. The even load distribution secured protects the subgrade, the truck, and the tires. This feature is one of the most important considerations in buying a roadbuilder's truck.

On the road the New Hug Gravity Dump Body is locked, wedge-tight, preventing rocking and racking.

Better balance and the low center of gravity permit the Hug Truck to safely put still more speed in the road job for 1924. Improved, original spring design also contributes to greater speed on rough hauls without excessive abuse to the chassis.

There are two sizes in the New Hug Truck line —one for the 4 and 5 bag Batch, and one for the 6 and 7 bag Batch.

Either one of these New Hug One Batch Mixer-skip Trucks, like the old ones, will quickly pay for itself on the job.

Hug Truck dumping dry aggregate into the mixer skip.

Keep the Mixer Going

Allowing half a minute for lost motion and inefficiency, every minute and a half a batch must be dumped in the mixer skip or an idle mixer will steal your road profits.

On a 7¼ mile concrete highway job, for one of the large companies in Illinois, twelve Hug Trucks kept the mixer always going. The average haul was 1.82 miles. The average cost per ton mile was 6½c., and repairs were too minor in nature to be included in the Operation Records! Twenty-seven other Hug Truck Fleet Owners in Illinois will be glad to tell you how the Hug Truck, with its practical roadbuilder's design, has reduced their costs and put new profit in the road job.

On Exhibition at Chicago

At the Road Show at the Coliseum in Chicago, from January 14th to 18th, in the first space to the left inside the Main Entrance, in Booths Nos. A-1, A-2, and A-3, the entire new Hug line will be displayed. You will not only find new value in the Hug Truck, but also a new Turntable, and a new Subgrade Planer.

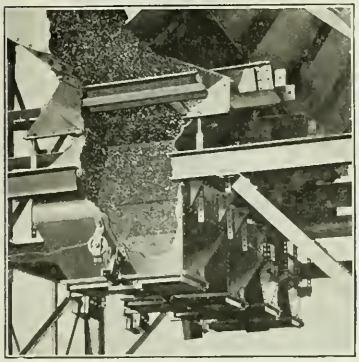
Whether or not you will be in Chicago, write today for descriptive folder.

Hug

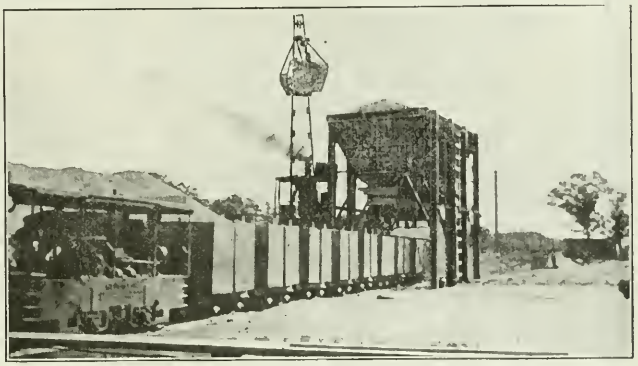
THE HUG CO.
Highland, Illinois

16 Batches-4 Minutes

ONE MAN *Measures and Dumps 16 Batches-8 Cars-in 4 Minutes.* TRAIN LOADED



Arrangement of Blaw-Knox Adjustable Measuring Batchers for 50-ton Suspension BATCHERPLANT. Can also be installed on any wooden bin.



Blaw-Knox Suspension BATCHERPLANT—75-ton capacity. General Construction Company, Gary, Ind.

"Kept the mixer busy"—says Sherwood Moe, President of the General Construction Co., Gary, Ind.—"averaged *four* minutes for loading eight cars of two 33-ft. batches each.

Besides—"in a run of 25,000 sacks we were 338 under the requirement of 3.23 sacks per lineal foot of 20-ft. pavement, which is of course within the 2% limit on the whole run."

Correct proportioning of sand and stone *saved cement.*

His Blaw-Knox BATCHERPLANT stored his aggregate—accurately measured it—loaded his batch boxes and kept the job moving.

AND—R. D. BAKER & CO., COCHRANTON, PA., LOADED THEIR BATCH CARS **WITHOUT STOPPING THE TRAIN.**

ACCURACY and SPEED in the measurement and loading of sand and stone is accomplished by the one-man BATCHERPLANT—whether used for industrial track or truck hauling; or for central mixing.

Learn more about the BATCHERPLANT—
Write for the catalog

BLAW-KNOX COMPANY

611 Farmer's Bank Bldg., Pittsburgh, Pa.

New York Baltimore Birmingham Chicago Detroit London, Eng.

TRADE MARK BLAW-KNOX REG U S PAT OFF

Mfrs. of
BLAW-KNOX
STEEL FORMS
TURNTABLES
CLAMSHELL BUCKETS
TRANSMISSION TOWERS
HANDY HOUSES

Batcherplant

STEEL STORAGE BIN and MEASURING BATCHERS

28 Pieces of American-LaFrance Motor Driven Fire Apparatus in Atlanta's Fire Department

Atlanta, Ga., famed in song and story, recognized the merits of American-LaFrance Fire Apparatus eleven years ago, when one pumper was ordered. Actual performance caused the officials of Atlanta to realize that American-LaFrance Motor Driven Fire Apparatus occupied the highest position in the fire apparatus field. As a result there are now 28 pieces of American-LaFrance Fire Apparatus in Atlanta's Fire Department.

Chief William B. Cody, of Atlanta, states that American-LaFrance Fire Apparatus has always distinguished itself by quick runs to fires and by unusual pumping feats.

Nearly 80 years devoted to building fire fighting apparatus have given us an experience impossible for others to duplicate. This experience coupled with constant engineering progress makes American-LaFrance the choice of communities that want the best.

Stone Mountain, Atlanta

Stone Mountain shown in the illustration is the world's greatest single mass of exposed granite. It is 867 feet high from the plain to its highest crest. It is more than 5000 feet long, 7 miles around the base and more than a mile from base to summit.

At the present time, the eminent sculptor, Mr. Gutzon Borglum is engaged in carving upon the face of this mountain the memorial to that "Great Gray Host" representing the valiant sons of the Confederacy. When completed, the memorial will be 1200 feet in length and more than 300 feet in height.

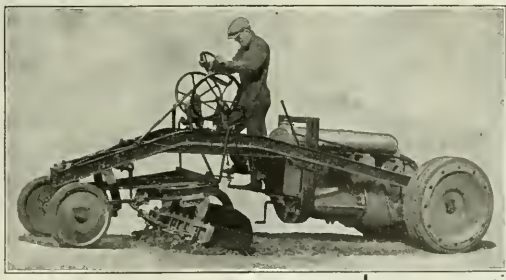
AMERICAN-LaFRANCE FIRE ENGINE COMPANY, INC.

BRANCHES
NEW YORK
BOSTON
ATLANTA
PITTSBURGH
CHICAGO
DALLAS

ELMIRA, N. Y.
CANADIAN FACTORY
TORONTO, ONT.

BRANCHES
DENVER
MINNEAPOLIS
LOS ANGELES
SAN FRANCISCO
WASHINGTON
PORTLAND

PATENTED DEC. 6, 1921. OTHER PATENTS PENDING.



Mr. Davis' letter gives a complete analysis of the cost of maintaining 557 miles of Indiana Roads with a Wehr One-Man Power Grader, including depreciation. But this low cost of road maintenance is not more important, than the fact which Mr. Davis cites, when he says: "I find it easier to maintain a section of road and keep it in shape with this outfit than with any other I have used." In other words the Wehr Grader simplifies your road maintenance problem.

INDIANA
STATE HIGHWAY COMMISSION
STATE HOUSE
INDIANAPOLIS, INDIANA,
September 19, 1923

H. Hinkle, Sup. of Maintenance
a State Highway Commission,
apolis, Indiana.

ir:-

llowing is my report of the Wehr Grader for a four week period from August 20th to September 15th. During this period the grader traveled 557 miles in 22 days, using 289 gallons of kerosene, 13 1/4 gallons of gasoline, 84 quarts of oil, 1/4 pound of cup grease, and 1/2 gallon of transmission oil. Expenses itemized as follows:-

289 gal. Kerosene @ 12.2¢		$ 35.26
13¼ " Gasoline @ 14.2¢		1.88
84 quarts oil @ 74.5¢ per gal.		15.65
1/4 pound cup grease		.20
1/2 gal. Transmission oil		.30
2 blades @ $8.00		16.00
Operator 22 days @ $4.00		88.00
Total cost of operation	---	$ 157.49

Figuring the cost of depreciation at $25.00 would make the total cost of operation $182.49 or an average cost of $8.30 per day, an average cost of 33¢ per mile.

I find it easier to maintain a section of road and keep it in shape with this outfit than any other I have used and at far less cost. My recommendation is that at least one be purchased for each superintendent at the present time. Attached are the reports covering the four week period designated.

Yours truly

A. A. Davis, SUPT.

AAD/T

557 MILES—22 DAYS' GRADER WORK

Road Maintenance Cost 33c. per Mile with a Wehr One-Man Power Grader

One man with a Wehr Power Grader, so reduces the cost of maintenance of streets and highways, that both Public and Officials in any locality must consider it a very proper and profitable investment.

The Wehr Grader is a complete maintenance unit. The 8-foot blade with the power of a Fordson back of it, easily keeps average road surfaces in fine smooth condition. Where traffic is heavy and road surfaces wear unevenly, the Wehr Scarifier quickly tears down the road surface to be reshaped with the Wehr Grader blade. And one man does the whole job alone, with one machine.

A demonstration of a Wehr One-Man Power Grader would suggest a way to completely reorganize your maintenance work, to make it absolutely dependable, and to reduce costs. One man with a day's training would cover more mileage with a Wehr Grader than three men with light horse drawn graders, or six men with heavy horse drawn graders. And this one man's work would give you better roads than is possible with any horse drawn grader.

Ask your local Fordson Dealer to give you full information on Wehr Graders. (Powered with Fordsons) or write us, giving your Fordson Dealer's name.

WEHR COMPANY, MILWAUKEE, WISCONSIN

533 30TH STREET

ATLAS
EXPLOSIVES
for construction work

ATLAS Ammite SAVES money in three distinct ways: It *cannot* freeze—and that means a saving of thawing costs. Under proper storage conditions, it can be kept indefinitely without deterioration—which means a big saving to many users of explosives. And, last but not least, the blasting itself costs less when the proper grade of Ammite is used—and better work is assured. Let the Atlas Service Man help you determine what grade of Ammite will save the most money for you.

AMMITE
—cannot freeze—

ATLAS POWDER COMPANY
WILMINGTON, DELAWARE

Branch Offices:
Allentown, Pa.; Birmingham, Ala.; Boston, Mass.; Charleston, W. Va.; Chicago, Ill.; Des Moines, Iowa; Houghton, Mich.; Joplin, Mo.; Kansas City, Mo.; Knoxville, Tenn.;

ATLAS EXPLOSIVES

Branch Offices:
McAlester, Okla.; New Orleans, La.; New York City, N. Y.; Norristown, Pa.; Philadelphia, Pa.; Pittsburg, Kans.; Pittsburgh, Pa.; Pottsville, Pa.; St. Louis, Mo.; Wilkes Barre, Pa.

SIMPLICITY is the outstanding feature of Wood-Detroit Hoists—just a piston and two gears, working in oil, comprise the vital *moving* parts of this time-tried dependable mechanism.

Contrast this with the gear trains, worms, splined shafts, jaw clutches, slides, guides, shafting under high torsion, lubricating devices, and similar constructions unavoidable where the necessarily large reduction is made through mechanical instead of hydraulic means.

WOOD DETROIT

Wood-Detroit Hydraulic Hoists have proved their dependability and efficiency in many thousands of installations and for nearly a decade and a half. By specifying Wood-Detroit, you avoid experimenting and uncertainty and assure satisfaction.

And a complete chain of branches and distributors cooperate with you to get maximum service from your equipment.

Wood Hydraulic Hoist & Body Company

World's Largest Makers of Hydraulic Hoists and Steel Bodies Exclusively.

7934 Riopelle Street **Detroit, Michigan**

Can you use a lower-cost explosive?

YOU may have used a certain explosive successfully for a long time but still it *may* not be the most economical.

The du Pont Company is continually reducing blasting costs by introducing explosives that do equal or better work at less expense.

This service is at your disposal.

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Exclusive Features Nos. 13 & 14

Steering Wheel and Steering Column

THE steering wheel is built up of alternate layers of rubber and canvas vulcanized together around a wire cable center. In addition to this vibration-absorbing feature, the outer, heavy layer of rubber gives a firm grip even with cotton or woolen gloves.

Rubber is also used in the steering column support to reduce vibration. Heavy fluted rubber rings within the dash bracket support prevent metallic contact between the column and the bracket.

These uses of rubber in both steering wheel and steering column combine to conserve the driver's energy to a marked degree.

The 27 exclusive features listed are the result of 23 years of specializing in motor transportation. Each one has played an important part in building the reputation which Mack Trucks have established wherever motor trucks are known.

THE COMPLETE LIST

1—Crankshaft	15—Steel Cab Sliding Doors
2—Cylinder Treatment	16—Front Sprocket
3—Engine Support	17—Pressed Steel Radius Rod
4—Case-Hardened Timing Gears	18—Blast Cooled Dash Radiator
5—Water-Cooled Oil Reservoir	19—Beltless Squirrel Cage Blower
6—Double-Screen Oiling System	20—Single-Rod Gearshift Control
7—Water Pump	21—Non-Metallic Flexible Clutch Disc
8—Exhaust Manifold	22—Dual Reduction Drive
9—Intake Manifold	23—One-Piece Banjo Type Rear Axle
10—Crankcase Inspection Ports	24—Full-Floating Construction
11—Interrupted Spline Shaft	25—Rear Axle Accessibility
12—Reverse Gear-Shift Lever	26—Drive Shaft Brake
13—STEERING WHEEL	27—Rubber (Shock Insulator) Shackles
14—STEERING COLUMN	

Send for illustrated and descriptive literature on all exclusive Mack features listed above.

INTERNATIONAL MOTOR COMPANY
25 Broadway New York City

Branches owned by this company operate under the titles of: "MACK MOTOR TRUCK COMPANY" and "MACK-INTERNATIONAL MOTOR TRUCK CORPORATION."

PERFORMANCE COUNTS

COLD PATCH

(1)
Repairing Bituminous Concrete

(2)
Same, two months later, showing repairs after being consolidated by travel

HEADLEY No. 1
AN ASPHALTUM EMULSION

For repairs and resurfacing.

No expensive heating plant required.

Can be used in wet or dry weather.

No time lost account wet materials.

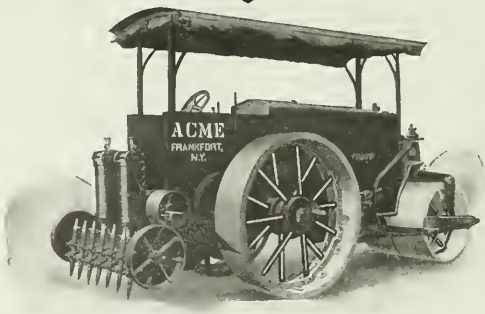
Write for descriptive booklets.

ASPHALT AND ROAD OIL

HEADLEY GOOD ROADS CO. FRANKLIN TRUST BUILDING PHILADELPHIA, PA.

ACME

Road Equipment for every Requirement



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We manufacture: Four-Cylinder Motor Road Rollers; Steam Road Rollers; Solid Cast Steel Frame Rock Crushers—Portable and Stationary; Elevators, Screens, Portable Storage Bins; Complete line Tom Thumb Graders; Portable Gravel Screening and Unloading Plants; Wagons, etc.

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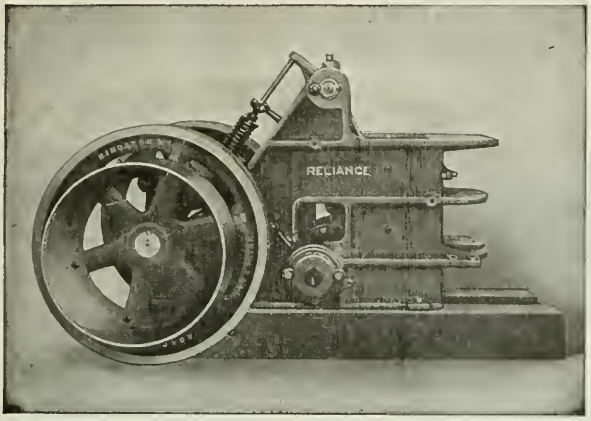

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We manufacture a complete line of **ROAD BUILDING, SAND and GRAVEL** and **QUARRY** equipment, including Crushers, Elevators, Screens, Bins, etc., in capacities ranging from **25** to **1,000 TONS** per day.

LET US POINT OUT TO YOU SOME OF THE SUPERIOR FEATURES OF OUR EQUIPMENT

Catalogue and Prices on Request.

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141 MILK ST., BOSTON, MASS. **KINGSTON, N. Y.** **114 LIBERTY ST., N. Y. CITY**

"REMOVED OUR CONCRETE FOR ONE-FIFTH

—the cost of hand work"—

That is what an Ogden, Utah, contractor said about the

Sullivan Portable Compressor and Sullivan Concrete Busters

which he used last spring on several miles of trench and for removing street pavement beside a railroad track.

He lists the following advantages which made money for him:

1—Fewer men needed.

2—Saved two-thirds to five-sixths of the time needed for hand labor.

3—Adaptability of the portable compressor to varied air uses, such as drilling, pumping, running mixers, hoists, etc.

The compressor is the:

Sullivan "WK-31," 150 foot, gasoline engine driven machine, 28 H.P.

The drills are:

Two Sullivan 65 lb. concrete busters, using chisel or gad bits—

They Will Enable You to Save Time and Labor on Your Job, Too.

Ask for Bulletin No. 3377-D

Sullivan Machinery Company

138 So. Michigan Avenue, Chicago

KEEP YOUR JOB MOVING

this winter with a "SCHRAMM" Compressor. The illustration shows a "SCHRAMM" Compressor being used for breaking ice-covered, frozen ground. May we help you with your problem?

SCHRAMM, INC.

Home Office and Factory: WEST CHESTER, PA.

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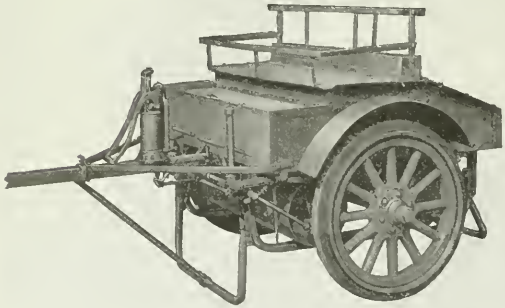
Chausse Oil Burning Tool Heater

The Chausse Tool Heater is one of the greatest labor, time and money saving machines made for asphalt street repairing. It can be started in less than five minutes; brings cold tools to proper temperature in 15 minutes; heats 14 or 15 tools and 3 buckets of cement at one time.



There are no ashes, no smoke, no sparks, no fuel to collect and haul. It is not affected by rain or wind, burns kerosene or distillate. Carries sufficient fuel for sixteen hours' burning at maximum heat. Has solid rubber tires and Timkin bearings. Can be pushed by one man or hauled noiselessly at any speed.

Used successfully in Chicago, Detroit, Milwaukee, and other cities.

Write for Circular and Prices

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206 Lincoln Building *Sales Agents Wanted* **Detroit, Michigan**

At the ROAD SHOW *in* CHICAGO, JAN. 14-18—

we will exhibit a new machine which will greatly interest those contractors using various grades of asphalt in road and street construction.

You are invited to inspect this machine at our exhibit located in the Coliseum.

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451 EAST PEARL STREET CINCINNATI, OHIO

12-Ton Type "E" Crawling Tread—40 ft. boom—¾-yd. bucket.

The Answer to Low Cost Material Handling. The solving of loading and unloading problems becomes simple when

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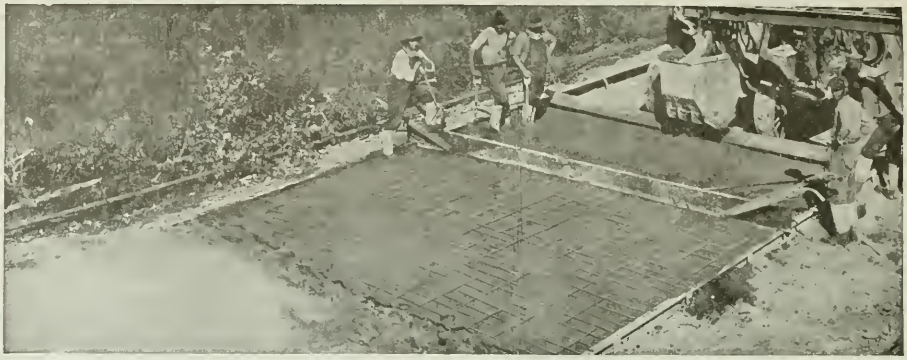

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The necessity of steel reinforcement in concrete roads is now generally recognized by leading engineers. The State Highway Departments of New York, Pennsylvania, New Jersey, Ohio, Maryland, Minnesota, Iowa, Florida, North Carolina, California and others, are specifying steel wire mesh in flat sheets.

Truscon Wire Mesh is furnished in widths and areas as desired, in flat sheets. The members are rigidly connected at right angles to each other so that the mesh remains in perfect form during handling.

The sheets are manufactured with the main members spaced 6" on centers, and the secondary members spaced 12" on centers. The sheets are cut in any desired length so that no lapping is required across the width of the road.

TRUSCON STEEL COMPANY, Youngstown, Ohio

Warehouses and Sales Offices from Pacific to Atlantic.
For addresses see phone books of principal cities. Canada: Walkerville, Ont. Foreign Division: New York.

"Snow Never Bothers Us"

"—we don't have to worry about securing enough laborers and we are saving money."

That is what road and street officials who are equipped with

THE Martin O.D.&G.CO. REGISTERED

Snow Plow

will tell you. One man and a team will do the work of a crew of hand-shovelers and open up a road in a remarkably short time. This is about the simplest and most efficient device you can buy.

A Martin Grader will do the same work as any other large machine, and yet it only costs about one-fifth as much. Instead of one grader you can buy five. That means five roads or streets can be cleared at the same time, where it would otherwise be possible to do only one. And a Martin will go where a big machine can't go.

When we said a Martin will do the work of a large grader, we meant just that. We have built the Martin at almost no cost for upkeep.

Get rid of the slow, costly hand-shovelers. Put a Martin Grader on 10 days' trial at our expense.

The Martin is an all-year-'round machine. In the summer it will transform your impassable roads into smooth, hard thoroughfares. Makes road complete from ditch to crown.

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Box 400, OWENSBORO, KENTUCKY.

Most sections have only 150 to 200 days a year of good weather suitable for outside work

Use the Shovel that WORKS EVERY GOOD DAY

When you have an ERIE

"delays are unknown"

"After my experience with different steam shovels and cranes as County Engineer of Chautauqua County, N. Y., I would not have anything but an ERIE. Delays are unknown with an ERIE, and upkeep is practically nothing." — *Wm. J. Knauer, Hitchcock & Knauer, Jamestown, N. Y.*

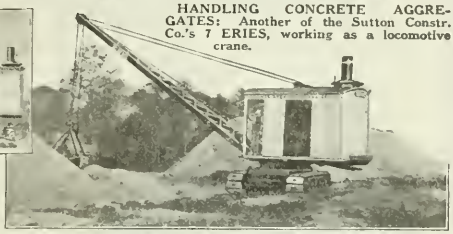
"The ERIE Shovel is far superior to other shovels in every way — there is no other shovel that can equal it for reliable service and low upkeep cost."— *R. C. Myers, Strange-Maguire Co., Salt Lake City, Utah.* (Own 2 ERIES).

How many days of good weather can you count on in a season? And how many of these days can you afford to lose because of machinery breakdowns?

It pays to use the equipment that is most

Reliable

ON HEAVY RAILROAD GRADING: One of the 7 ERIES owned by the Sutton Construction Co., Ashland, Kentucky.



HANDLING CONCRETE AGGREGATES: Another of the Sutton Constr. Co.'s 7 ERIES, working as a locomotive crane.

25 years of shovel and crane service with only 5 days lost time

Hundreds of ERIE owners are getting service like this:

"In our six years of experience with six ERIES we have not lost more than five days altogether on account of breakdowns. Although most of our work has been heavy and difficult excavation, repair cost has been mighty low. For durability and service the ERIE is in a class by itself—and we have seen all makes of shovels, and obtained all possible information about them." — *W. D. Sutton, Pres. Sutton Construction Co., Ashland, Ky.* (They have just bought another ERIE and now own 7 — and altogether have had between 25 and 30 service years with ERIES.)

Many carefully checked upkeep records show that ERIES cost only about ⅓ as much for upkeep. Even more important than the saving in actual repairs, is the SAVING IN VALUABLE WORKING TIME.

Write for our new 72-page book of actual output and upkeep cost records, covering the performance of 48 shovels on every kind of work. *Ask for Bulletin H-70.*

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ERIE STEAM SHOVEL CO., ERIE, PA., U. S. A.
Builders of ERIE Steam Shovels and Locomotive Cranes
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MAKES GOOD ROADS

A scientifically prepared coal tar for the construction and maintenance of roads and streets.

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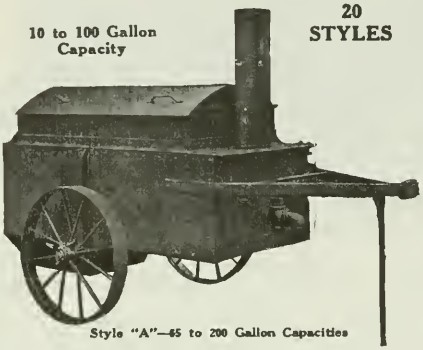
TAR AND ASPHALT HEATING KETTLES

10 to 100 Gallon Capacity

20 STYLES



Style "A"—65 to 200 Gallon Capacities

NON-LEAKABLE WELDED
(Held by the Weld)

If desired kettles can be equipped with Hyatt ROLLER BEARINGS and RUBBER TIRES

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THE weak spot in a concrete road is that thin transverse line—*the expansion joint.* There is where the traffic pounds, there is where Jack Frost tries to do his bit.

The space between abutting blocks of concrete must be *permanently* filled with a *resilient* material.

The Pennsylvania Joint with its high percent of pure asphalt, fills the joint permanently with a *continually resilient* material. Easy to handle, flexible for odd shapings.

THE ASPHALT PRODUCTS COMPANY
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Manufacturers of

THE *Pennsylvania* JOINT

Write for our folder that gives the main facts about the Pennsylvania Joint. Our special tests are available for engineers.

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Bronze and Cast Iron
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Highway Bridges, Sidewalks, Municipal Plants, etc.

We are equipped to furnish these plates at very reasonable figures.

Send us description of plates needed. Quotations promptly submitted.

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MURPHYSBORO, ILLINOIS

Ideal Municipal Dump Wagon

Western Studebaker Model

HERE is a dump wagon which can not be excelled for municipal work. As the name indicates, the **Western-Studebaker** model is a combination of the two old favorites named—has the best features of both. It is designed for use on hard roads where extra weight needed to give extra strength will not prove a handicap.

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Western Wheeled Scraper Company

Earth and Stone Handling Equipment

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These plows will keep your streets and roads free from snow

Brute strength reinforced with channel iron and cross braced with solid ribs—La Plant-Choate Snow Plows meet every emergency and requirement in snow fighting. Proper style and model for any standard make tractor applicable to snow removal work.

"DRIFT BREAKER" Snow Plow

The crowned leader—a big V type plow which cuts thru ice, snow, drifts or crusts. Side wings and plow on same frame. Easy to work—powerful lift. The curve of the mouldboards rolls the snow off, out of the path and leaves a clean, wide swath in its wake.

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THE BUTLER VACUUM STREET SWEEPER

Is a Complete Unit—

It is built to stay on the street, AT WORK, day and night, sweeping all types of pavement. The BUTLER does not sprinkle water ahead of the broom and operates in an absolutely dustless manner.

It is efficient and economical.

The BUTLER SWEEPER is rugged and compact in construction, its simplicity insuring non-interrupted service.

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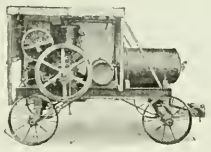
DEPENDABLE "DOMESTIC" POWER UNITS



"Domestic" No. 50 Portable Compressor

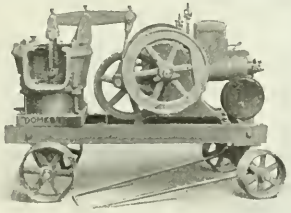
Public Service Companies, Municipal Departments and Contractors are finding more uses every day for gasoline engine driven Pumps, Hoists and Portable Air Compressors.

The Units illustrated are only a part of the "DOMESTIC" line of "Dependable Power Units"—which, when "put on the job" will save you time and money.

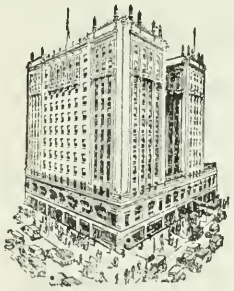
Send today for descriptive Bulletin "K"

Domestic Engine & Pump Co.

Main Office and Factory: Shippensburg, Penna.



"Domestic" Trench Pump



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The Sheridan-Plaza is strongly intrenched in the favor of Chicagoans and out-of-town visitors because of its strategic location in the heart of Chicago's finest residential district and one of its richest retail centers.

Added to these advantages is its accessibility from the Loop—by elevated express and surface cars, and by motor busses which run through Lincoln Park.

Moreover, the beautiful Main Restaurant and the Narcissus Grill offer food of notable excellence at moderate prices.

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W. C. D. TRANKLE, President

GEORGE C. OBER, Manager

Comfortable rooms with private baths, $3 a day and up. Reservations are advisable. Exceptional garage accommodations.

New ONE HORSE ASH WAGON

Built to meet the insistent demand from small villages, institutions, country estates and manufacturers for a small bottom dump ash wagon. Watson quality all the way through. Special folder free upon request.

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WATSON DEPENDABLE DUMP WAGONS

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TILTER
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MIXER

MOST REASONABLY PRICED MIXER IN AMERICA

Built in All Sizes and Types.

Get New Prices—Terms. Just off Press.

THE AMERICAN CEMENT MACHINE CO., Inc., KEOKUK, IOWA
Branch Offices in All Principal Cities

HOTEL CONTINENTAL

Broadway at Forty-First Street
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"Center of New York's Activities"

A Modern, Up-to-Date, High-Class Hotel

Five minutes from the Pennsylvania and Grand Central Terminals, within easy access of the retail shopping district and surrounded by forty theatres.

300 OUTSIDE ROOMS

Each with Private Bath

RATES—Single, $2.50 per Day
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Comfort of our guests our first consideration

ADAMS

Adjustable Leaning Wheel

GRADERS

"Do Most Work per Dollar or per Day"

Get a copy of our new Catalog

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INDIAN ROAD OILS

"WIPE THE DUST FROM YOUR HIGHWAYS"

No matter where they come from, how they are made, who sells them, or how much you pay for them, you can not obtain better road oils than Indian Road Oils.

INDIAN REFINING COMPANY, Inc.

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PENNSYLVANIA CEMENT

WAS SELECTED FOR THE CONSTRUCTION OF THE

BETHLEHEM BRIDGE

OVER 90,000 BBLS. HAVE BEEN USED TO DATE

MANUFACTURED BY

THE PENNSYLVANIA CEMENT COMPANY

AT BATH, PA.

GREEN *Power Drag* Scrapers

For excavating, grading, gravel pit operations, stripping, back filling, levee work, storage handling.

Green Power Drag Scrapers can be set up to deliver from pit to waste pile, storage bins, screens, crushers or loading.

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TRADE MARK REGISTERED U.S. PATENT OFFICE

KOPPEL

Manufacturers of

Industrial Railway Equipment
Portable Track and Switches
Roadbuilders' Trucks and Batch Boxes
Contractors' Square Box Dump Cars

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2 In 1

Ordinarily the contractor has one plow for general purpose or furrow work and another plow for rooter work or tearing up old pavement.

THE WIARD NO. 69—Road or Contractors' PLOW—does the work of both and answers any and all purposes. It also means a less investment and keeping in stock extra parts for one plow only.

STEEL BEAM GUARANTEED AGAINST BREAKAGE FOR ONE YEAR FROM DATE OF SALE

Write today for descriptions.

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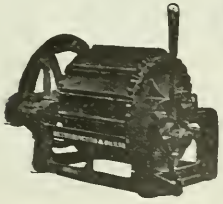

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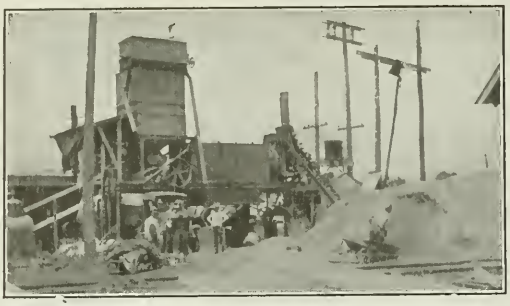

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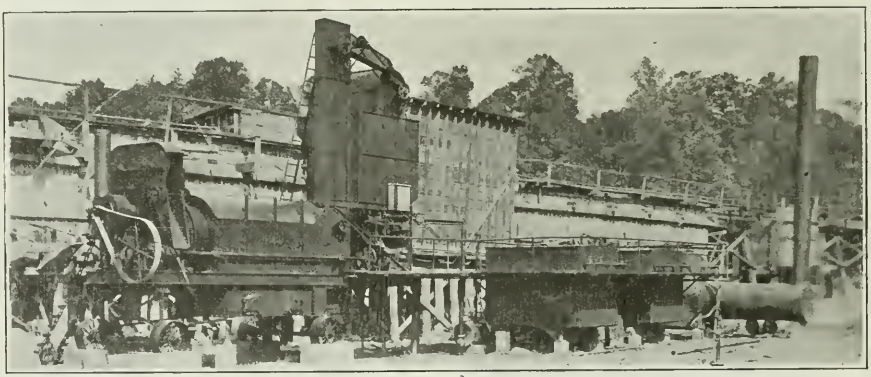

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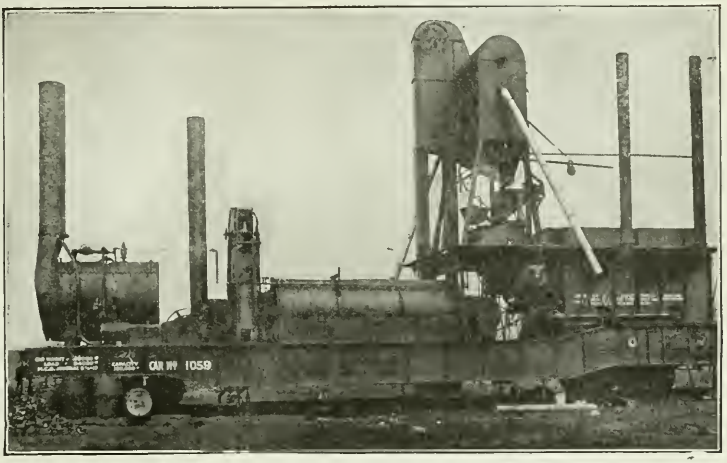

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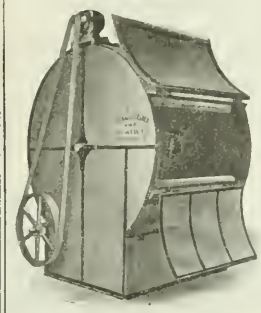

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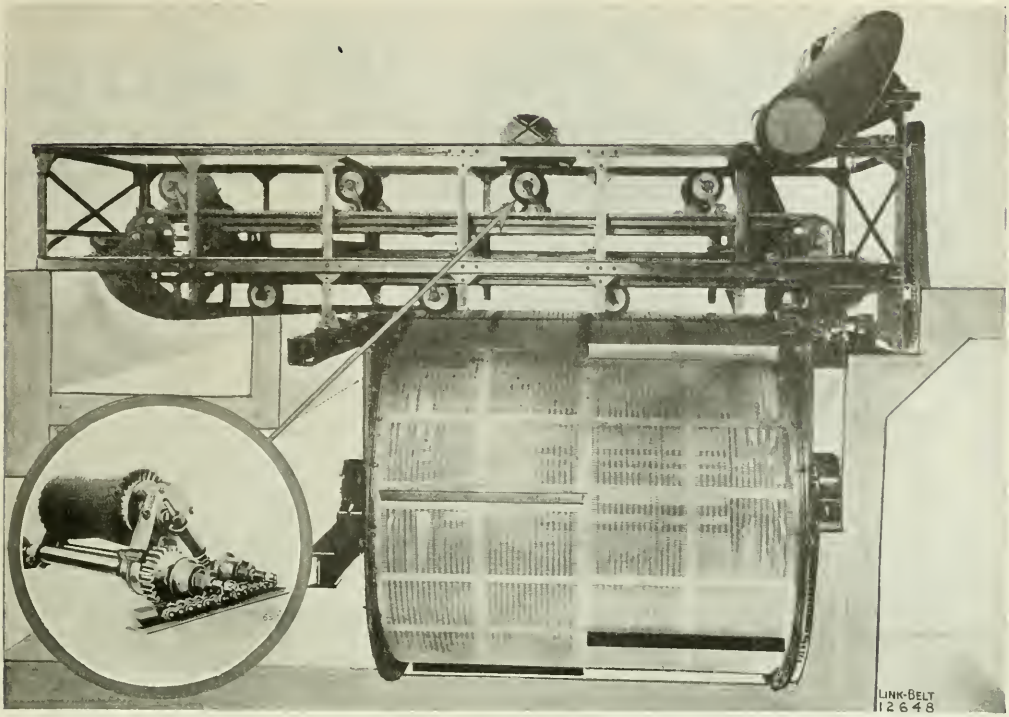

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